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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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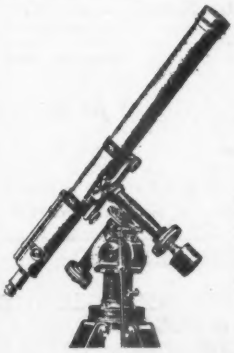

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Education and the Nation.

ON Sunday, November 27, Mr. Fisher, President of the Board of Education, speaking in Whitefield's Mission, London, on "Our Schools," said:

"Education is a great unifying influence, not only between classes, but also between nations. The estranging influences between man and man are not rooted in the externals of situation or wealth, but are founded in differences of intellectual acquisition and of intellectual and moral outlook. There still persists the delusion that the education of the poor must be different, not only in amount, but also in quality, from the education which is at the service of the more affluent members of the nation. But the poor, even more than the rich, stand in need of the best possible education, since they lack the home advantages of the wealthy. Indeed, in the crowded areas of the cities the school plays an even greater part than the home in the formation of the national mind. The elementary school may not give all the results we are entitled to expect, though there has been great progress made in the last generation through the development of a spirit of humanism in the schools. It will not become fruitful in result until something is done to provide education for the vital period of adolescence."

This was the spirit that animated Mr. Fisher in the drafting of the measure which culminated in the Education Act of 1918, and served to mark the public appreciation of the benefits of education and the great progress made since the Education Act of 1902. Mr. Fisher stated that day continuation schools were provided for in the Education Act of 1918, but, owing to financial circumstances, at the present time they could not develop the system adequately. He added that the children of the nation needed more schools, more books, and better teachers, and if the nation was in earnest they would assuredly get them in time. Yet the Board of Education has continually thwarted the progressive efforts of the more enterprising local authorities in the provision of new schools; it hampers the provision of Central Schools in London even where such provision can be made by the reorganisation of existing elementary schools, and it checks the development of schools where physically defective children can receive remedial treatment.

There has arisen—and it is an extremely hopeful sign of the public interest in the value of education—a strong demand for the advantages of higher education, and thousands of children in all parts of the country are eager for admission to secondary schools; but the Board offers no encouragement to that end; in fact, it has sanctioned the raising of the fees in such schools, thereby preventing the poorer children from taking advantage of them, and

the same policy is being pursued with respect to the much-needed nursery schools for children under five. Day continuation classes during two years, as provided for by the Act, for young people who have left the elementary school at fourteen in order to enter into employment, are, except in the London area, practically a dead letter, the Board refusing its sanction to the fixing of the appointed day.

The Committee of business men appointed by the Chancellor of the Exchequer, with Sir Eric Geddes as chairman, to consider the national expenditure with a view to drastic economies in the various spending departments has presented its Report to the Cabinet, but its full details have not been made public. It is rumoured that there is a proposed reduction in the total estimates for the year 1922–23 of 195,000,000*l.*, of which the education estimates are responsible for 16,000,000*l.* As showing the spirit in which this question has been approached, Lord Inchcape, one of the influential members of this Committee, and the chairman of the P. and O., said, at a recent meeting of the shareholders of his company, that "education is an excellent thing in its way, but there are limitations to its economic usefulness." Lord Haldane, at a meeting held at London University on December 17, arranged by the London Head Teachers' Association, dealt effectively with Lord Inchcape's observations, and showed how much the progress of the nation in every department of industrial life and even in his own particular business of shipping has been due to education. He said:

"Lord Inchcape could not sail a single steamer but for the education of the great inventors and men of science which made it possible, nor would his staff know how to handle the instruments but for the training they have received from their teachers. Modern business cannot stand still, neither can education. Other nations realise the value of education, and will get ahead of us if we do not; if we neglect it, hard times will come, when we shall be driven belatedly to reverse the policy threatened to-day in order to recover our resources and progress, which will have failed us through our misunderstanding of the true meaning of economy."

In this respect the decision of the Treasury to reduce the grant to the universities from 1,500,000*l.* to 1,200,000*l.* will seriously hamper these institutions in their endeavour to get and to retain competent teachers, and will impede scientific research on which a further advance in knowledge and especially industry, alike in the spheres of manufactures and of agriculture, so largely depends. The joint meeting of the general council of the Trade Union Congress and the Labour Party Executive, held in London on December 14, views this policy with profound disapproval, which can do virtually nothing, it says, "to relieve the national finances, but which will be a serious blow to higher education."

An important manifesto has recently been issued by the Teachers' Registration Council, entitled "Education and National Life," for presentation to his Majesty's Ministers and in the expectation that it will be signed by many eminent men and women. It refers to the national danger which attends any attempt to reduce expenditure on education, and urges that the recent extension of the franchise has made it the more necessary to open all possible avenues of knowledge and enlightenment as preventives of error and half-truths in politics, economics, and social relationships. A complete and generous system of education will fortify the State against civil unrest and strife, while serving to widen the vision and enrich the lives of individuals. We were led in the tragic ordeal of the war to perceive the faults of our previous educational system and to frame the new proposals embodied in the Education Act of 1918. But that measure is not really in operation, and the newly awakened desire of working people for further knowledge is left unsatisfied. The signatories recognise the need for a careful survey of our national resources and for thrift in all public and private expenditure, but hold that thrift should be exercised with discrimination and not so as to curtail educational opportunity. They conclude with the desire to see our country take its place in the van of civilised and enlightened communities and regard public expenditure on education as a wise investment which will bring to this and succeeding generations the rich rewards of civic greatness and private contentment.

It is to be hoped that this weighty manifesto from an influential body of well-wishers to education may receive speedy and favourable consideration at the hands of the Government, in order that the provisions of the Education Act of 1918 may be put into practical operation without further delay, and also that the full grant of 1,500,000*l.* be restored to the universities so as to encourage research in all departments of knowledge and give them the opportunity of fully developing their resources in the vital and permanent best interests of the nation.

Fifty Years of Electrical Science.

Fifty Years of Electricity: The Memories of an Electrical Engineer. By Prof. J. A. Fleming. Pp. xi+371. (London: The Wireless Press, Ltd., n.d.) 30s. net.

IN giving us his memories of the past fifty years, Prof. Fleming has compiled a noteworthy work. "The book makes no claim," he writes, "to be a systematic treatise on electricity or electrical engineering, but is simply intended as an attempt to place before the intelligent general reader a fairly comprehensive view of the chief triumphs of applied electricity during the last half-century." The intention is carried out with the clearness of style and the lucidity of expression we have long learned to expect from the author. He may be assured that, as he hopes, it will "assist junior engineering students in obtaining a preliminary acquaintance with the outlines of a subject they will study in greater detail in other books," while to those who are not going to be professional physicists or engineers it will give a far more useful appreciation of what electricity is and what it has done than they gain from their attempts to verify Ohm's law or measure the magnetic moment of a piece of magnetised steel. Electrical progress lends itself in a very special way to treatment of this kind, but if it were possible to do for other branches of science what Fleming has achieved for his the gain would be very great.

From Sturgeon, who in 1825 constructed the first electro-magnet, to Einstein, whose work is referred to in one of the later chapters of the book, is nearly twice fifty years, but the work of the first half of the period, though fundamental, is passed over briefly in an introductory chapter. We are reminded of the importance of Sturgeon's discovery, of its extension by Joule and Faraday and Henry, and its almost immediate application to the electric telegraph by Cooke, Wheatstone, and Morse, culminating in the Hughes printing telegraph, for which the first U.S. patent was secured in 1855; the laying of the first Atlantic cable, 1857–58, which survived for only two months; the work of William Thomson, Lord Kelvin, based on his Royal Society paper of 1855 on "The Theory of the Electric Telegraph," leading to the mirror galvanometer (1858) and the siphon recorder (1867) after the successful laying of the 1866 cable.

Electrical telegraphy in England was at first developed entirely by private enterprise, and in 1870, when the business was taken over by the State, the various companies owned altogether some 16,000 miles of lines. Up to this time, the date at which Prof. Fleming's memories start and his detailed history begins, electrical engineering had been almost entirely concerned with telegraph work. The Society of Telegraph Engineers and Electricians—afterwards to become the Institution of Electrical Engineers—was in 1870 the only electro-technical society in England.

But the seeds of a greater development had been planted. Electro-magnetic induction was discovered by Faraday in 1831. From that followed the early magneto machines of Saxton (1833) and Clarke (1835); the Siemens armature was devised in 1856, the Gramme ring by Pacinotti in 1860. Wilde, in 1850, had used electro-magnets instead of permanent magnets for the field-coils of a machine, and this was followed, in 1867, by the invention of the dynamo; the machine became self-exciting.

The account of these fifty years occupies some fifty pages of Prof. Fleming's book; for the next fifty the remaining 300 pages barely suffice. In six chapters details are given of the advance in all directions. Telegraphs and telephones, from Hughes's first printing instrument and Graham Bell's early telephone to the modern multiplex type machines and the automatic telephone exchange, are all described. Then we have dynamos, alternators, transformers, and motors, from 1870 to 1920, from the first Gramme and Siemens machines of some few kilowatts to the giants of the present day. Another chapter treats of electric lamps and lighting; yet another of supply stations, storage batteries, and railways; while fifty pages are devoted to electric theory and measurements, from Kelvin and the work of the first British Association Committee on Electrical Units in 1861–62 to Maxwell and theories of the ether, the discoveries of J. J. Thomson and Rutherford, and the influence of Einstein on modern physics. The final chapter deals with wireless telegraphy. Commencing with the theoretical work of Maxwell and Hertz, it passes in review the experiments of Hertz, Lodge, and Admiral Jackson, concluding with those of Marconi and his associates. An account is given of the valve detector devised by the author in 1904, and of the improvement due to Dr. Lee de Forest, by which it became the triode valve and amplifier for wireless waves.

This very brief *résumé* will indicate the scope and extent of the work. The limitations of space prevent any detailed account, and indeed no such account is necessary beyond the statement that all important developments in electrotechnics of the last fifty years are described with the well-

known skill of the author, who has added to our libraries a most useful and interesting work. Both he and the Wireless Press, which has produced the book, may be cordially congratulated on the result of their labours.

Fermat's Last Theorem.

Three Lectures on Fermat's Last Theorem. By L. J. Mordell. Pp. vii+31. (Cambridge: At the University Press, 1921.) 4s. net.

THE "last theorem of Fermat" states that if x, y, z, p denote positive integers, the equation $x^p+y^p=z^p$ is impossible if p exceeds 2: thus no cube can be the sum of two cubes, and so on. If the theorem is true when p is 4, or an odd prime, it is true for all other integral values of p. For three centuries this theorem has baffled the efforts of all who have attacked it, although it has attracted the attention of all first-rate arithmeticians, and a great number of amateurs. For $p=3, 4, 5, 7$ comparatively simple proofs have been discovered; but so far none of these has led to a complete generalisation.

The first great advance in the theory was made by Kummer, in connection with his researches on cyclotomic integers. He showed that if the theorem is false for any particular odd prime p, then p must not be a factor of the numerator of any one of the first $\frac{1}{2}(p-3)$ numbers of Bernoulli. This very recondite test rules out all values of p below 100 except 37, 59, 67. By additional criteria Kummer was able to prove the theorem for these exceptional primes, and hence for all values of p from 3 to 100 inclusive.

Not many years ago (1907) a prize of 100,000 marks was set aside for the first who succeeded in giving a complete proof or disproof of the theorem. Quite recently, new criteria, independent of Kummer's, have been discovered, which have to be satisfied by odd primes p for which the theorem is false, and the simplest of these is the condition $2^{p-1}\equiv 1 \pmod{p^2}$, discovered by Wilferich in 1909. Other tests of a more or less similar kind have been accumulated, and the net result is that any value of p for which the theorem is false must exceed 7000. Gauss's tables of quadratic forms warn us not to draw any conclusions from this result; in fact if N is any *assigned* integer, however large, a proof that the theorem is true unless $p>N$ gives us no information about the truth or falsity of the theorem in general.

Mr. Mordell's lectures give a clear and interesting account of the history and present state of this subject. Lecture I. gives a statement of the theorem, and a summary of the work done by Kummer's predecessors; Lecture II. is on Kummer's researches, and more recent investigations of similar type; and Lecture III. gives an account of various results obtained by Libri, Sophie Germain, and others. Full references are given to the original papers, so that a reader within reach of a good reference library can make himself acquainted with details of all that has been done hitherto.

A perplexing circumstance, often alluded to, is the fact that, in a private note, Fermat distinctly asserted that he had proved the theorem. Now Fermat was never convicted of a false assertion, and only once of a wrong conjecture; on the other hand it is extremely improbable that Fermat's proof, if he had one, was in any way analogous to the work of Kummer and his successors. It is not, perhaps, unreasonable to hope that a proof may be found, some day, derived from Diophantine analysis proper, combined with a process of induction, and possibly with some application of analytical geometry, or theory of equations, or both. A really gifted youth, approaching the problem without knowledge of modern analysis, might throw a quite new and unexpected light upon it.

Mr. Mordell's pamphlet ought to do much to stimulate our rising mathematicians, and we hope that it will have a large circulation.

G. B. M.

Chemistry of Coke-oven and By-product Works.

Coke-oven and By-product Works Chemistry. By T. Biddulph-Smith. Pp. x+180+7 plates. (London: Charles Griffin and Co., Ltd., 1921.) 21s.

THE author states in the preface that his object in compiling this book is to furnish a concise manual covering, so far as space will allow, the general work required for the chemical control of coke-oven and by-product works. As regards the variety of subjects treated, he has doubtless achieved his object, but it is to be regretted that the apparent exigencies of space have caused the manual to become so concise in certain sections as to detract appreciably from the value of the work as a whole.

The most valuable section of the manual is that relating to the coal-tar naphthas. There is no doubt that the author has taken considerable pains to collect together the work of some of our best analytical chemists on methods of evaluating the constituents of coal-tar naphthas—work which

was carried out during the war period when the adequate examination of these products was a matter of such great importance. Although most of the methods dealt with have already been described either in technical journals or in the proceedings of technical societies, chemists will welcome the accumulation of this information within the covers of one volume. Moreover, the admirable summary of "The Constituents of Coal-tar and their Properties," compiled by Dr. Spielman, appears in a revised form as an appendix, and the inclusion of this information may prove useful to the coke-oven chemist by saving reference work.

The rest of the book is disappointing. In describing analytical methods the author has obviously attempted to do more than supply indications of the method recommended by him, but has failed to furnish sufficient detailed information to be of real service to the works chemist.

The chapter dealing with the fractions of coal-tar other than the naphtha fraction is meagre, and the weakness of this section accentuates the fact that chemists have not yet given adequate study to the analytical methods required in the examination of the heavier fractions of coal-tar, which are no less important than the naphtha distillate. It is in this section of the book that a recommendation appears which would have shocked those older and well-established chemists who attempted to teach us our subject, and who, not living in these times of efficiency systems and labour-saving devices, paid due reverence to instruments by which accurate measurements might be made. The recommendation refers to the crystallisation of crude tar acids, the instructions being to cool the liquid, "stirring continually with a Fahrenheit thermometer graduated in tenths of a degree."

The treatment accorded in other sections of the book to the analysis of gases, calorimetry, and the examination of chemical products made and required in the recovery works is all too brief. The analysis of coal-gas, which is acknowledged to be so intricate as to require considerable experience before trustworthy results can be expected, is dealt with in a few pages, whilst the method of procedure recommended is archaic. The estimation of naphthalene is carried out by a method which would be quite unpractical if small quantities of ammonia were present in the gas, though no mention is made of this fact.

Finally, the manual contains the usual collection of tables and conversion factors in the second appendix—so useful to reader, author, and publisher.

E. V. EVANS.

Lichens.

(1) *Lichens.* By A. L. Smith. (Cambridge Botanical Handbooks.) Pp. xxviii + 464. (Cambridge: At the University Press, 1921.) 55*s.* net.

(2) *A Handbook of the British Lichens.* By Annie Lorrain Smith. Pp. vii + 158. (London: The British Museum (Natural History), 1921.) 6*s.* 6*d.*

(1) FOR many years botanists have been without a guide to the large mass of facts that have been added year by year to our knowledge of lichens. Miss A. Lorrain Smith has therefore done a good work in compiling a very comprehensive handbook on this group of plants. The growth of our manufacturing and even our garden cities proves fatal to all except a few insignificant lichens. They are driven away to those far-off parts of the country where the air is still fresh and pure. This circumstance very possibly, but the absence of any comprehensive handbook on, and guide to, the lichens certainly, is a reason why so little interest is taken in this group. Yet, ecologically, it is one of the most interesting groups. Lichens grow on the outskirts of vegetation, as pioneers of the plant world, preparing the way for moss, fern and flowering plant. They are most intimately in touch with the substratum in its virgin condition. Few ecologists, however, properly consider lichens. Anatomically, the lichen thallus very directly reflects the nature of the substratum. A great deal, however, still remains to be done in this direction. The elaborate and careful work of the late Abbé Hue has, unfortunately, not brought much morphological order into our knowledge of lichen structure.

The whole question of the dependence of one organism, whether animal or plant, on another, or even others, again whether animal or plant, is every day becoming of greater interest. The views of various lichenologists on this matter are placed before us by Miss Lorrain Smith, but the simple word symbiosis is the term most favoured. It does not define the relationship between alga and fungus in too great a detail. Terms like helotism (due, by the way, to Warming and not to Nienburg), parasitism, consortium, endosaprophytism, and others, may cover certain individual cases, but the relationship of alga to fungus certainly varies in different species, or possibly even in different individuals of one species growing under different conditions. There is no doubt that on the whole the lichen-fungus fully controls growth and reproduction of the gonidial algæ,

though within certain limits both take place freely. Lindau, however, has described how in certain hypophlœodic lichens the alga actually forges ahead of the fungus.

The various branches of the subject have been very fully dealt with by Miss Lorrain Smith, but we think that not sufficient reference has been made to Exsiccata, which have played such an important part in lichenological nomenclature. We also consider that the book as a whole is not well illustrated. Many of the line drawings are quite inadequate as illustrations in a handbook of this standard. The half-tone figure on p. 117 appears to us to be *Cladonia uncialis* rather than *Cladonia furcata*, whilst Fig. 135 on p. 416 does not recall to us *Parmelia omphalodes*, which it purports to represent. Apart from these blemishes, which we consider rather serious, the handbook is a storehouse of valuable information, and Miss Lorrain Smith deserves the thanks of all lichenologists and botanists for the care and thoroughness with which she has completed her task. Some readers might possibly object that they are left too much to draw general conclusions for themselves.

The price of the book, unfortunately, is prohibitive except for public and college libraries.

(2) We are sure that Miss Lorrain Smith's "Handbook of the British Lichens" will answer its purpose very well and help both botanist and collector to name their specimens, instead of being compelled to depend for this on foreign books. The book, however, is only a key to the "Monograph of the British Lichens," by Miss Lorrain Smith, the price of which, again, is well-nigh prohibitive. We may express the hope that this little book will help to create renewed interest in a group of plants the study of which was at one time keenly followed in this country.

O. V. D.

British Mineral Resources.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 19, *Lead and Zinc Ores in the Carboniferous Rocks of North Wales.* By Bernard Smith. Pp. iv+162+3 plates. 1921. 5*s.* 6*d.* net. Vol. 21, *Lead, Silver-lead, and Zinc Ores of Cornwall, Devon, and Somerset.* By Henry Dewey. Pp. iv+72. 1921. 2*s.* 6*d.* net. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.)

THE two volumes under notice form an important contribution to our knowledge of British mineral deposits, and afford satisfactory evidence that Dr. Flett is continuing energetically the valuable series of reports inaugurated by his predecessor at the Geological Survey. The scheme of both volumes is identical and is upon the lines with which previous reports had already familiarised us, but the economic importance of the deposits discussed therein differs very widely. The lead and zinc veins of North Wales have not only been highly productive in the past, but also may well take rank in the future among the leading British lead-producing mines, whilst those of the south-west of England present little more than academic interest. Needless to say, none of the mines discussed in either volume is at work just now; in fact, in the whole of Great Britain there is not a single lead or zinc mine capable of working save at a loss at the present time, probably a result of Government interference in the control of industries.

In North Wales such well-known mines as the Halkyn mines and others in the Holywell-Halkyn area, the Minera mines and other adjoining mines in Denbighshire are fully described, together with numerous less important mining properties. It is abundantly clear that in all these cases the great difficulty to be overcome is the enormous influx of water, which has rendered the economic working of these mines practically impossible. An interesting account is given of the various deep adit drainage schemes by which it is proposed to unwater some of the more important mining areas down to a considerably greater depth than has hitherto been reached. Although he does not specifically say so, it would appear that Mr. Bernard Smith entertains no doubt of the ore holding down to the greatest depth that would thus be rendered available. Incidentally he shows that the 35,000*l.* which the Government advanced for unwatering the Halkyn area have been wasted and have never yielded any return whatever. It can only be hoped that some satisfactory scheme for unwatering this area may be devised and carried into execution, though it is difficult to see how this can be done until British lead-mining reaches a sounder economic position than that with which it is faced to-day.

As regards the lead mines in Cornwall, Devon, and the Mendip Hills, it can only be said that there is practically no likelihood at all of any serious revival of the lead-mining industry in these parts, and it is fortunate that the task of collecting information as to the past history of these mines has been undertaken before it is too late. Mr. Dewey has done a useful piece of work in carefully compiling an account of these mines, which will be especially interesting to the student of mineral deposition.

H. LOUIS.

Our Bookshelf.

Guide Pratique de Sylviculture. Par Dr. F. Fankhauser. Troisième édition française par M. Petitmermet. Pp. 348. (Lausanne, Genève, et Paris: Payot et Cie, 1921.)

DR. FANKHAUSER'S elementary text-book on forestry is used in Switzerland for the instruction of agricultural students and working foresters; that it has great merits is evidenced by its appearance in five German and three French editions. The work is remarkable for its clear style, excellent illustrations, and admirable choice of subject-matter. The introduction, concerned with the utility of forests, explains their importance in creating industries, in regulating water supply, in preventing erosion of the soil, etc., in a country like Switzerland, where there is so much of what the author calls "absolute forest soil," or land that cannot be put under any other form of cultivation. The forests of Switzerland cover, in fact, 2,300,000 acres, about 23 per cent. of the total area of the country, and are credited with a production of about 42 cubic feet of timber per acre annually.

The first part of the book—forest botany—after some elementary notes on morphology and physiology, deals separately with each forest tree, giving its botanical characters, distribution, reproduction, growth, sylvicultural features, enemies, diseases, wood, and other products. Only one foreign conifer is included, *Pinus strobus*, and it is evident that exotic trees, like Douglas fir, Sitka spruce, and Japanese larch, so much favoured in England for planting at present, are not valued in Switzerland as yet. The next part of the book, concerned with the art of sylviculture, is an excellent summary of the different kinds of forests and how they are created, maintained, and cared for. Much attention is paid to practical subjects, like choice, collection, testing, and sowing of seeds of forest trees, nursery treatment, artificial plantations, natural regeneration, and thinnings.

Other chapters deal with utilisation, a subject which includes felling and transport of timber, and the properties and uses of wood, and with the protection of forests from wind, frost, fire, drought, insects, fungi etc. The conclusion of the work is devoted to the simple engineering and building problems that are handled daily by foresters in Switzerland.

The Principles of Immunology. By Prof. H. T. Karsner and Dr. E. E. Ecker. Pp. xvii + 309 + 2 plates. (London: J. B. Lippincott Company, 1921.) 21*s.* net.

THE researches of Pasteur on immunisation against fowl cholera, swine erysipelas, anthrax, and rabies, and the discovery by Behring and Kitasato of the antitoxic properties of the blood serum, constituted the beginnings of the science of immunology, which since 1890 has grown to incredible dimensions and in every direction has insinuated itself into the domains of practical diagnosis and therapeutics. It is no longer within the capacity of one or even two individuals to deal authoritatively with the subject, although this was attempted, and with a fair measure of success, a year or two ago by such a master as Jules Bordet. Naturally many text-books exist on immunity, and the present work of Karsner and Ecker must be ranked as one of the more successful among these. The authors have handled a goodly part of the periodical literature, and have applied to their reading and study a critical acumen which is conspicuous by its absence in most books of this class. Their knowledge is of a most modern kind, and they have thrown over allegiance to the Ehrlich "side chain" hypothesis which dominated immunology for so many years. Naturally in a work of its size Karsner and Ecker's book is highly condensed, and is, in fact, restricted to fundamental principles. They state that it is primarily designed for medical students and busy practitioners. As a text-book for students working for the higher examinations it can be cordially recommended, and it may possibly be read with profit by the more intellectual types of practitioners who have previously prepared themselves for the intricacies of the subject by the perusal of some more elementary work on the subject.

We notice a number of misprints, especially in the names of several of the authorities cited, and it may be said that some of the few illustrations are crude. Otherwise it may be recommended as an accurate guide to those who wish to study the subject with profit in the periodical literature of the day. W. B.

When Buffalo Ran. By G. B. Grinnell. Pp. 114 + 8 plates. (New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press, 1920.) 10*s.* 6*d.* net.

THE supposed autobiography of a Red Indian boy of some seventy years ago, when the veteran author was himself a small boy. The tribe is not mentioned, doubtless with intention; but Mr. Grinnell probably had in his mind the Cheyenne, which he knows so well. Anyhow, the book is not for ethnologists, but for boys, and the one on whom we have tried it pronounces it "topping." Written in the simplest English, without affectation, the story brings out all the noblest features of the tribal life that has passed away. There is abundance of sympathy, but no sentimentality.

High Tension Switchgear. By H. E. Poole. (Pitman's Technical Primers.) Pp. ix + 118. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

IN this brief introduction to a large subject, the author contents himself with a summary of the principal features of present practice in the design of oil-break switches for the voltages in common use in this country. A few notes on isolating links, surge arresters, high-tension fuses, and testing pressures have also been inserted.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Atmospheric Refraction.

THE correspondence on terrestrial refraction from Mr. Mallock and Dr. de Graaff Hunter in NATURE of June 9, p. 456, and August 11, p. 745, raises a paradox which I think must have puzzled many readers of NATURE besides myself. Mr. Mallock is, of course, quite correct in stating that the diminution of density of the air observable under ordinary conditions is practically linear for moderate increases of height above the earth's surface, and that, consequently, the refractive index of the air may for moderate increases of altitude be taken as diminishing linearly at such a rate that it would reach vacuum value at the height H of the homogeneous atmosphere. Dr. Hunter is equally correct in pointing out that Mr. Mallock's reasoning, based on the above-mentioned observational fact, leads to a value of k, the coefficient of terrestrial refraction, which is almost exactly twice as great as that found by observation under ordinary conditions. Dr. Hunter does not, however, point out what I think is the real fallacy in Mr. Mallock's argument.

The difficulty is not to be got over by any consideration of temperature-gradient in the air, although it is well known that variations in the temperature-gradient constitute the chief cause of variations in terrestrial refraction. The only way in which temperature-gradient could affect Mr. Mallock's result would be by its requiring a change in the value (4·32 sea-miles) which he adopts for the height H of the homogeneous atmosphere. Whether we calculate H for air at a uniform temperature, as is usually done, or on the assumption of a diminution of temperature with increase of height at the rate ordinarily observable (say 1° C. for each 200 metres), we obtain a value of H which is nearly the same as that used by Mr. Mallock in his argument.

May I suggest that the solution of the riddle is to be found in Mr. Mallock's supposition of a "*plane vertical* wave-surface starting from P," whereas the rays of light from a terrestrial point must give rise to an approximately *spherical* wave-surface? In the diagram (Fig. 1), which represents a vertical section through the homogeneous atmosphere with the curvature of the earth neglected for simplicity, a plane wave-surface HPO would change its position to BAC in the time t, where HB and OC are proportional to the velocities of light at H and O. But in that time rays from a point P would reach points D and E, such that $PD-PA=\frac{1}{2}(PB-PA)$ and $PA-PE=\frac{1}{2}(PA-PC)$, because the average velocity along PD would be the mean of the velocities at P and H, and, similarly, the average velocity along PC would be the mean of the velocities at P and O. It is easy to see that this gives a radius of refractional curvature exactly twice as great as that found by Mr. Mallock, and consequently leads to a value for the coefficient of terrestrial refraction which is in agreement with observation and with the tables ordinarily employed by navigators for the dip and distance of the sea horizon.

It may be worth while to mention here a very likely source of confusion in comparing the values of the coefficient of terrestrial refraction k found by different observers under different conditions, and especially by observers in different countries. There are two definitions of k in use by surveyors, one of which makes its numerical value double that given by the other. An assistant of mine who read Dr. Hunter's letter was greatly surprised at his statement that $k=0{\cdot}133$ "is *not* a value ordinarily met with in practice," because in Egypt we ordinarily use $k=0{\cdot}13$, and our trigonometric levels derived from observations made in the afternoon hours when refraction is at its minimum and steadiest value are found to agree surprisingly well over great distances with those found by spirit-levelling. The explanation of the apparent discrepancy between Dr. Hunter's statement and our experience is that we follow the Continental practice in defining k as the ratio of the curvature of the refracted ray to the curvature of the earth, while Dr. Hunter and most English writers define it as half this quantity.

It does not seem to be very generally known that a rational formula for calculating the coefficient of terrestrial refraction at any point where the barometric pressure, air-temperature, and temperature-gradient are known was advanced by Jordan so long ago as 1876. This formula, which is given, together with an account of the theory on which it rests, in Jordan's "Handbuch der Vermessungskunde," Band 2, is

$$k=0{\cdot}2325\,\frac{B}{760}\,\frac{1}{(1+\alpha t)^2}\,(1-29{\cdot}39n),$$

where k is the coefficient of terrestrial refraction, defined as being the ratio of the curvature of the ray to that of the earth, B the barometric pressure in mm., α the coefficient of expansion of air at constant pressure, t the air-temperature in degrees C., and n the temperature-gradient in degrees C. per metre of height.

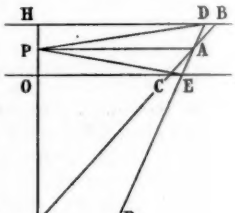


FIG. 1.

Jordan's theory is probably not quite complete, in that it omits any consideration of variations in the humidity of the air; but it does take account of variations of pressure, temperature, and temperature-gradient, and these are probably the principal factors affecting the value of k. The resulting formula is very simple and easy of application, and, so far as I have been able to test it in the Egyptian deserts, I have found it to give results which are in good agreement with those of observation. It appears also to accord very satisfactorily with Indian experience; for when applied in the two examples given by Dr. Hunter in his letter, one at sea-level and the other at an altitude of 19,000 ft., it yields (allowing for the difference in the definition of k) results identical with those which were found by Dr. Hunter to agree well with numerous observations.

JOHN BALL.

Survey of Egypt, Cairo, December 14.

IN NATURE of June 9, p. 456, a letter appeared from Mr. A. Mallock giving a proof that the path of a nearly horizontal ray through the earth's atmosphere is a circle of about 14,900 miles' radius, and later (August 11, p. 745) Dr. de Graaff Hunter, of the Indian Survey, wrote controverting Mr. Mallock's statement, and asserting in effect that the radius of

the ray as deduced from measured values of the coefficient of refraction is distinctly higher, being about six and a half times the earth's radius, or about 26,000 miles.

Both letters contain an inadequate presentation of the facts of atmospheric refraction in that they assume that the path of the ray is circular. A very much fuller investigation is necessary in order to account for the distance of the visible horizon or its depression below the true horizontal.

Starting with the assumption that the atmosphere is in static equilibrium, leading to the differential equation $dp=-g\rho dh$, and with the pressure-density-temperature law $p=C\rho T$, a further assumption must be made before a complete solution can be arrived at giving pressure, density, and temperature in terms of height. A simple assumption to make is that of a uniform temperature-gradient expressed as $T/T_0=1-\alpha h$. For the isothermal conditions $\alpha=0$; for the adiabatic, α corresponds to a drop of 1° C. per 330 ft. increase in height. The integration of the general equation leads, provided h does not exceed 200 or 300 ft., to $p=p_0-g\rho_0 h$ and $\rho/\rho_0=1-(g\rho_0/p_0-\alpha)h$. Since by Dale and Gladstone's law ρ is proportional to $n-1$, we obtain without difficulty

$$n=n_0-0{\cdot}00029(g\rho_0/p_0-\alpha)h.$$

Further, it is not difficult to show that with a ray that is nearly horizontal the radius of curvature σ is given by the approximate equation

$$1/\sigma=0{\cdot}00029(g\rho_0/p_0-\alpha).$$

This equation will give any value we like for σ provided we assume a suitable temperature-gradient. If we put $\alpha=0$ (the isothermal state) we get substantially Mr. Mallock's figure. If we take the adiabatic gradient the radius is about 20,000 miles. If we take a fall of temperature of 1° C. per 200 ft., Dr. de Graaff Hunter's value results. A gradient of 1° C. per 100 ft. gives a flat ray and an atmosphere of uniform density. To obtain greater curvatures than Mr. Mallock's figure the temperature-gradient must be reversed.

It is no use to take this formula and expect it to be uniform over even very narrow levels when close to the surface of the sea. The temperature-gradients in the first 30 ft. (the average height of the bridge of a ship above the sea) are very frequently greater than any of the gradients mentioned above, and show wide variations in that space. In such case the path of a ray from a visible object more than a mile away is nothing like circular, but may have variations in its curvature of 300 or 400 per cent. I am aware that the value of the coefficient of refraction mentioned by Dr. de Graaff Hunter is used in books of nautical tables in computing the dip and distance of the sea horizon, but I am aware also that actual measurements of the dip at sea show that tabulated values are frequently in error, sometimes even of the wrong sign! Measurements made by Blish off the coast of California showed that a zero dip is quite possible. In the Red Sea the sea horizon is often refracted above the true horizontal.

Consider the path of the ray of light from the horizon to the observer's eye when the dip is zero. The path touches the earth's surface at the horizon and touches a concentric sphere of perhaps 30 ft. greater radius at a point only six or eight miles away. The radius of curvature of the ray must be greater than the earth's radius at the horizon and smaller at the observer—a maximum at the first point and a minimum at the second. Neither Mr. Mallock's figures nor Dr. de Graaff Hunter's can deal even approximately with a ray-path of this nature, and I think it may be asserted without question that to take adequate account of the path of rays of light through the lower levels of the atmosphere demands consideration, not only of the curvature of the ray-path, but also of the first and second differentials of the curvature.

THOS. Y. BAKER.

Admiralty Research Laboratory, Teddington, Middlesex, December 22.

The Message of Science.

Two great questions are raised in the abridgment given in NATURE of December 22 of the notable address delivered by Sir Richard Gregory during the Edinburgh meeting of the British Association. They are:—(1) How can an interest in, and respect for, science in all its branches, with their essential unity, be developed locally? (2) How can the work of the British Association be so broadened and improved as to ensure that it will yield—to use the words of Sir Richard Gregory—"a statement of ideals and of service, of the strength of knowledge and of responsibility for its use"?

Local scientific societies consist of three types:—(1) Sectional bodies interested in general engineering problems or in the technical details of certain sciences applied to the chief industries of the district. (2) Natural history societies or field clubs. (3) Literary and philosophical societies which provide in a few large towns a good library and series of winter lectures.

With regard to the first type little need be said. They fulfil their specialised functions fairly well, but their work would be greatly improved, and made gradually more attractive, if it were possible to secure an outlook on the broad field of science. Sir Richard Gregory said in the course of his address in Edinburgh: "Whatever Labour may declare officially, it is scarcely too much to say that artisans in general show less active interest in scientific knowledge now than they did fifty years ago." This statement is true, not of artisans only, but of all classes. The demand has been made on science: "Make us rich and comfortable." Science, in a large measure, has responded. But with wealth and comfort has come a lessening of respect for knowledge. The highest things that science can give—an ardour for truth, the power to rise above sordid interests, the desire to become co-workers in an infinite process by which soul is drawn from matter—have been set aside, and we have been landed in a back-wash.

I do not think any revolutionary changes are necessary locally in order to bring back the enthusiasm which linked science a generation ago to human liberty and human justice. Sir Richard Gregory speaks of a federation of local societies "to proclaim the message of knowledge from the housetops." It may be necessary, first of all, for these societies to find out what the real message of knowledge is, but they need not wait for perfect vision; much can be done while they are only groping.

What is wanted, above all things, is such an infusion of earnestness as will arrest the displacing power of the mere lantern lecture. The lantern has been a good servant, but it is threatening to become a bad master. At present the great trouble of the secretary of a literary and philosophical society is to make his organisation pay its way. The chief thing for which the organisation stands is often sacrificed in the attempt to secure popular support. This attitude must be abandoned even if abandonment leads into the wilderness. The message of science will come back from there with renewed constraining power. There are thousands waiting for the message. What

stands in their way is the lack of faith and of courage on the part of the present directing agencies. Probably the most practical suggestion of immediate value that has been made is that the various scientific societies in any town should arrange meetings for study and discussion—the discussion which seeks agreements and does not emphasise differences—and that the underlying, but not obtrusive, object of the meetings should be the progressive connecting of science with individual and corporate conduct.

The second question has many factors in common with the first. The British Association has suffered from the mental reaction which set in a quarter of a century ago. It is a much smaller factor in the thought and life of the age than it was a generation ago. I think the first helpful change desirable is the recognition of a new principle in the selection of a president and in the making of his annual address. Above all things, the president should stand for the unifying of the sciences, and his address should make some definite contribution to that unity, even when it is built largely on the recent achievements of one section of knowledge.

It is only through a conception, becoming ever clearer, of this unity that science can become the "chief formative factor of modern life." The yearly appeal of a president may do much, but more would be achieved if a day were set apart for the study or discussion of the thoughts and facts he has communicated—a study or discussion, I say again, which should emphasise agreements and not differences.

Progress in this direction might receive a healthy impetus from the universities. They, too, have lost a considerable amount of influence. They are not, at home or abroad, leading humanity. The note of real universality is departing from them. Here again the first practical improvement will come from the manifestation of greater care in the selection of the principals of the attached colleges. They ought to be something more than skilled administrators. They, too, have a great unifying function.

This unifying work might be facilitated if there were periodical meetings of the various professors and lecturers for the study of unifying problems. That does not, I admit, promise to help them immediately to overcome the financial difficulties which are now laming them to a terrible extent and driving them to seek greater support from an overburdened State. But if the universities, encouraged by a steadily increasing enthusiasm for science locally and centrally, were themselves to become again great inspirers of thought, they would soon cease to be troubled by the lack of pence.

W. ROBERTSON.

Middlesbrough, December 29.

Cohesion.

THE theory of cohesion put forward by Dr. Herbert Chatley in NATURE of August 18 is logically based on those of other investigators, and, consequently, does not involve any new element. In all these theories cohesion is made to depend on centrally directed forces which follow either the inverse square law of gravitation or electrical attraction, or that of some other inverse power higher than the second. Dr. Chatley says: "It is difficult to conceive of one force having all these properties, but perfectly simple to imagine an attraction and repulsion combined that will do so, provided that *the attraction decreases more slowly with separation than the repulsion.*" He takes the ground that the force of cohesion as stated by him is related to those following the inverse square law, and that the question of the relation between them is of great importance.

Now it is a matter of common observation that two free liquid spheres on coming into contact with each other always coalesce. The force which causes this is evidently a force *enveloping* their masses, and not a force attracting them. This enveloping property of surface tension was noticed by Maxwell and others; but the theory which makes it depend on molecular attraction renders it impossible to conceive of such a force as enveloping *molecular* masses.

The present writer has adduced (*Phil. Mag.*, June, 1921) very strong, if not conclusive, evidence that the same force which causes liquid spheres to coalesce also causes the free molecules of a gas to coalesce or cohere. It cannot, therefore, be explained by molecular attraction. The alternative is that *it is an elemental force acting, not in lines, but over areas.* As such it is a universal property of the surface of both liquid and solid mass extending to molecular dimensions.

Fortunately, however, there is very definite and easily verifiable evidence that cohesion, and adhesion also, is due to a surface force, whatever its nature may be, as can be seen from the following simple experiments which will be published later in fuller detail.

Spheres of mercury, ranging from 0·05 mm. to 1·5 mm. in diameter, were hung from a drop of water wetting a glass surface above. Each one fitted into an inverted hemispherical cavity in the water, with a well-defined angle in the contact circle where the water surface joined the mercury surface. With a specially adapted microscope the diameter of the sphere, the width of the contact circle, and the angle between its water arm and the vertical were measured. From these measurements, W, the weight of the mercury sphere, and T, the vertical component of the pull of the water surface on the mercury, were calculated for a large number of spheres. The results showed that for small spheres T greatly exceeded W, but tended to become equal to W when the spheres were at the point of falling off. The ratio T/W decreased gradually from about 6 to 1, thus showing that the surface force of the water pulling on the mercury in the periphery of the contact area was more than sufficient, except in the limit, to support the weight.

Similarly, mercury spheres, with diameters from 0·05 mm. to 2·25 mm., were suspended from a horizontal glass surface. They were attached to the glass either directly or by suspending them from water as before and allowing the water to evaporate. The mercury surface was joined to the glass surface in the periphery of a wide circular contact area, and formed a definite angle with the glass surface. Measurements were made as before, and W and T (for mercury) were calculated. The results showed that, as the spheres increased throughout the range, the ratio of T/W decreased from the surprisingly large number of more than 6000 to about 2. Had T, however, been calculated from $\sigma=270$ instead of $\sigma=547$, the decrease would have been from about 3000 to 1 as before, and hence 270 may be regarded as an approximate value of the surface tension of glass. The increasing values of T/W for the smaller particles would account for the persistence with which molecules of a gas condense on a glass surface.

Further, small particles of any insoluble solid become attached to any surface above by the evaporation of a connecting water drop; or, if the particles be clean and small, they become attached to any clean surface by simple contact with it. This is amply confirmed by extended observations.

Now there is no reason to think that the force of cohesion is not of the same nature in the case of two solids as it is in the cases of a liquid and a solid and

of two liquids. Moreover, as it has been shown that two free molecules of a gas cohere (coalesce) from this same cause, it is justifiable to conclude that in all cases down to molecular dimensions cohesion is simply *a surface force pulling in the periphery of the contact area perpendicularly to that area.* It may be remarked also that these results furnish no evidence of the so-called molecular attraction.

By calculation this force binding two molecules of water together is $2{\cdot}05 \times 10^{-8}$ dynes; of mercury, $7{\cdot}7 \times 10^{-8}$ dynes. These agree with Dr. Chatley's statement that (molecular) cohesion is of the order of 10^{-6} dynes. Again, in the case of two molecules cohering in this manner the enveloping force can have a range not greater than two molecular diameters, while for larger molecular masses the range may be as great as three or four molecular diameters. It thus fulfils the condition for the range of action. In comparison with their gravitational attraction this force binding two water molecules together is of the order 10^{12} times as great. It is of the same order as the electrical attraction of two oppositely ionised molecules just before they come into contact. It causes a pressure on the interior molecular mass of the same order as the intrinsic pressure of the liquid. It does appear, then, that one force can be conceived as having all the properties of cohesion.

The conception of this force as a cause of molecular phenomena appears to be, in fact, fundamental. It solves the problem of surface tension; it explains, as we have seen, both cohesion and adhesion, and it accounts satisfactorily (*Phil. Mag., ibid.*) for the latent heat of condensation. But besides all this there is the remarkable coincidence that the force itself is located, or performs its function, in the precise area bounding free mass that the phenomena of reflection and refraction of light take place and electrons have their movement. These considerations give point to Dr. Chatley's concluding words: "It would appear that a complete solution of the macroscopic properties of matter would also solve the question of the inner structure of the molecules and atoms."

WILSON TAYLOR.
Physics Laboratory, University of Toronto,
Canada, November 15.

The Resonance Hypothesis of Audition.

ADDITIONAL evidence in favour of the resonance hypothesis of audition has been found recently.

The study of long-distance telephony has shown that low-pitched notes travel more rapidly than do those of high pitch, owing to the impedance of the electrical circuits. Mixed tones must, therefore, arrive with phase relationships between the high and low tones quite different from those with which they started.

In spite of this, even such complex sounds as those composing human speech are found to suffer but small apparent change in quality and distinctness during transmission. And this statement appears to apply equally to wireless telephony, where similar changes of phase must occur.

These facts suggest that the ear responds to tones quite independently of their relative phases, and therefore that true harmonic analysis must take place in the organ of Corti. A survey of the different types of harmonic analysers used in physics, for tide production and the like, shows that such harmonic analysis is invariably performed by a series of some type of resonator. Presumably, therefore, since the ear can carry out harmonic analysis, it also must contain resonators.

To test the premises more thoroughly the following experiment was carried out:—

Two electrically driven tuning-forks, emitting pure tones, were connected to separate battery and switch circuits, and were mounted on separate tables, so that while they vibrated independently their tones entered the ear of the observer simultaneously. They were tuned so that their tones had rates of vibration in the ratio of 1 and 3, this ratio being chosen because of all pairs of tones these give the largest changes in the form of the sound wave-curve as the relative phases of the tones are changed. Thus with one phase relationship the sound wave-curve has a single sharp, well-marked peak, whereas with another phase relationship two peaks are found, having a trough between them. If, then, the ear is affected at all by the form of the sound wave-curve, these two tones, combined in different relative phases, should show it. The experiment was performed by causing the higher-toned fork to sound continuously, the lower-toned one being turned on and off at irregular intervals, so that the relative phases should be chance ones. No difference whatever in the quality of the sound could, however, be detected by the observer. The response of the ear appeared to be quite independent of the relative phases of the tones, and, therefore, we must conclude that the ear effects a true harmonic analysis by means of resonators.

If the above experiment is repeated with two sources of tones that are not free from overtones it is found that the ear does readily detect differences in the quality of the sound as the relative phases of the tones are altered. For example, if Helmholtz's syren is used with, say, 18 holes operating in the lower wind chest, and 6 holes in the upper, then there are found to be 18 regularly spaced positions where the lower tone predominates, and 18 intermediate positions in which the upper tone predominates.

These effects are produced by the summation and interference between the upper tone and the second harmonic overtone of the lower tone. When holes of both wind chests are exposed simultaneously, summation occurs, and the upper tone predominates, whereas when the holes of one chest alternate with those of the other, interference occurs which weakens the upper tone, so that the lower tone predominates.

Many years ago there was considerable controversy as to whether the ear could, or could not, detect difference of phase. The above experiments suggest that pure tone free from harmonics may have been used by one school, and impure tones containing harmonics by the other, because in this way their difference in opinion could be readily explained.

C. R. G. COSENS.
H. HARTRIDGE.

King's College, Cambridge.

The Action of Sunlight.

IN NATURE of December 15 Sir Oliver Lodge is good enough to refer me to some experiments on the antiseptic action of sunlight which he carried out long ago in association with the late Prof. Marshall Ward. I have not yet been able to see the memoir to which Sir Oliver Lodge refers, but I believe that I am already well acquainted with it, and have been able to quote its essential findings on many occasions in connection with the demand for the abolition of the coal-smoke curse—thanks to an admirable account of Marshall Ward's methods and results, referred to the year 1892, in Sir James Crichton-Browne's "Light and Sanitation," an address delivered in Manchester in 1902 (Sherratt and Hughes, 27 St. Ann Street, Manchester). Particularly I value the last paragraph, in which Sir Oliver Lodge praises the anti-

septic and innocent quality of the sunlight just as we get it after filtration by the "unpolluted atmosphere."

But after seeing the clinical action of sunlight at Leysin under Dr. Rollier and at the Treloar Hospital under Sir Henry Gauvain, and reading the papers of Sonne (*Acta Medica Scandinavica*, vol. 54, fasc. 4, "The Mode of Action of the Universal Light Bath," from the Laboratory of the Finsen Medical Light Institute, Copenhagen) mentioned in my previous letter, I am absolutely certain, as anyone else would be, that there is more in the curative action of sunlight than its bactericidal effect. In a recent lecture before the Physiological Society of University College, entitled "The Physiology and Therapeutics of Sunlight: Facts and Questions," I cited instances and showed photographs of many cases where the value of sunlight could not have depended upon its antiseptic power. Sonne's view is that sunlight warms the blood without appreciably raising the general body-temperature, that this produces the valuable, without the injurious, effects of fever, and that this action is obtainable by the proper use of sunlight, and by that alone.

The practical importance of this fascinating physiological problem is apparent to me after recent visits to certain sanatoria, otherwise admirable, where I have been told that I should see the sunlight employed, and have found, for instance, that open air and diffused daylight, the latter reaching the face and possibly the hands, were regarded as the equivalent of Rollier's treatment; or that the children were scrupulously put under awnings or sent to school in an adjacent wood whenever the sun shone. The pitiful statistics of these places, compared with those of Rollier and Gauvain, point the moral.

Since first drafting this letter I have seen, thanks to Prof. Leonard Hill, new records of work done by Prof. A. F. Hess in New York, showing the cure of experimental rickets in animals fed and continuing to be fed on a diet which invariably produces rickets—when they were placed in sunlight for a few hours daily. No mere antiseptic action is here in question.

With rare exceptions, we do not yet know what heliotherapy consists of in this country; no one yet knows its action, nor even the pure physiology of sunlight. Meanwhile, we are carefully depriving many patients of their one chance of life, and quacks and others are using all manner of artificial lights in therapeutics as if they were equivalent to, or better than, the sunlight, which, according to Sonne's experiments—nicely consorting from another point of view with those of Sir Oliver Lodge—is incomparable.

The Smoke Abatement Committee has now published its admirable Final Report, and reiterates now my plea for an inquiry such as Carrel, I am told, is about to undertake at the Rockefeller Institute in New York, but which no one, not even Prof. Leonard Hill, our great student of the air and temperature relations of the body, is yet making here into the action of sunlight. I believe that the restoration of sunlight to our urban populations, mostly darkened in slums and smoke, is the next great task of hygiene in this country.

C. W. SALEEBY.

Royal Institution, January 2.

Units in Aeronautics.

A LARGE number of equations in aerodynamics appear in the form $R=k\rho SV^2$, where R, ρ, S, V are the reaction, density of the atmosphere, surface, and relative wind velocity.

Since both R and ρSV^2 have the dimensions of force, k is clearly a numerical coefficient unchanged by transformation from one self-consistent system of dynamical units to another, *e.g.* from foot, pound, second, poundal to centimetre, gram, second, dyne.

In transforming to an inconsistent system, k will in general be altered, but the inconsistencies may cancel each other in particular cases so far as to leave k unaltered. For example, if a gravitational unit of force is introduced g times the consistent unit, then we may write $R=k\rho SV^2/g$ pounds *weight* in the British system, or grams *weight* in the c.g.s. system. And while the numerical values of both R and g vary inversely as each other, the value of k is not affected if the system is otherwise consistent.

Prof. Bairstow ("Applied Aerodynamics," p. 119) maintains that the gravitational unit of force is the natural one, and to get rid of the local value of g that mars the consistency of his dynamical equations he introduces a new unit of *mass*, the "slug" of (local) g pounds mass, the use of which he restricts to the measurement of atmospheric density. Then putting $\rho'=\rho/g$ he can write $R=k\rho' SV^2$ in the same form externally as before, and read off the value of R in pounds weight instead of in poundals, all without showing g explicitly.

In this way, in his opinion, "it appears that the divergence of language (*sic*) between science and engineering would disappear."

But if we apply this method of measuring the density of the atmosphere to the estimation of the lift of an aerostat we get, putting m=density of hydrogen/density of air, $(1-m)\ \rho' \times$ volume$=R$ *slugs weight* ($=gR$ pounds weight$=g^2R$ poundals!).

Altogether it seems more satisfactory to teach engineers the physical meaning of Newton's laws of motion than to invent units which evade them, just as it has proved better to teach them the elementary notation of the infinitesimal calculus than to devise "calculus-dodging" demonstrations.

A. R. LOW.

London, December 8.

Self-fertilisation in Mollusca.

As the question of self-fertilisation in the more highly organised invertebrates is of considerable importance from the genetic point of view, I would like to direct the attention of readers of NATURE to a publication (Acta Soc. pro Fauna et Flora Fennica, vol. 40, No. 2, 1915), a copy of which I have just received from the author, Dr. A. Luther. It constitutes an important addition to the evidence for the occurrence of self-fertilisation in mollusca, as Dr. Luther states that he succeeded in rearing two generations by self-fertilisation in *Agriolimax agrestis*. I have recently pointed out (Proc. Malac. Soc., vol. 14, 1921) the value of Künkel's work on Arion in this respect; but at the time Dr. Luther's results were not known to me, as the publication was not available and had not figured in the "Zoological Record." Should these important observations be finally confirmed and the technique improved so as to produce more than two generations, a very valuable contribution to genetic study will be achieved. Dr. Luther's work, however, emphasises the necessity for conducting a study of environmental conditions in order to secure improved viability.

I may point out, perhaps, that though quite a number of cases of self-fertilisation have been recorded in Pulmonata by Lang, Holzfuss, and others, the subject is by no means fully explored either with regard to the distribution of the phenomenon among Pulmonata or the circumstances in which it occurs.

G. C. ROBSON.

British Museum (Natural History),
Cromwell Road, London, S.W.7, December 23.

The Law of the Heart.[1]

By PROF. E. H. STARLING, C.M.G., F.R.S.

THE discovery by Harvey of the circulation of the blood, and of the part played by the heart in carrying on this circulation, is one of the few scientific discoveries which have become common knowledge. We have to think of the body as a collection of mechanisms or machines, each one of which is doing some form of work for one common end—*i.e.* the preservation of the body. For this work the oxidation of the food taken in at intervals during the day provides the energy; thus each part of the body must be supplied not only with food derived from the alimentary canal, but also with the oxygen taken in with the air we breathe into the lungs. Like any other machine, each body mechanism produces, as a result of this consumption of the food, waste gases and other waste products which have to be carried to the lungs or to the kidneys and there cleared out of the body. It is for this reason that the existence of the higher animal demands a common fluid, the blood, which can carry food, oxygen or carbonic acid, and is maintained in continual circulation between all the organs of the body, so that the alimentary canal, for instance, may serve for the maintenance of all parts, and the lungs can supply oxygen to these parts or excrete the carbonic acid which is produced as a result of their activity.

But a uniform mechanical circulation would be of little value to the body, since the activities of all its parts vary within wide limits. Thus, during muscular exercise the activity of the muscles may be increased tenfold or more, and this increase means a corresponding augmentation in their call for oxygen and in the quantity of waste products, especially carbonic acid, that they produce. Since the oxygen is carried by the blood, it follows that for the continued functioning of the muscles these must receive a blood supply which is ten times greater during activity than during rest if their activity is not to be brought to an end by a species of suffocation. Therefore, in any violent exercise involving the greater number of the muscles of the body, the circulation must be increased in force seven to ten times, and the heart, which is the pump maintaining the circulation, must under these conditions do from seven to ten times as much work as during rest.

The Mechanism of Adaptation.

What is the mechanism of these adaptations? How is it that the heart is able to carry on a circulation which may vary from a passage of 3 litres of blood per minute up to 30 litres of blood per minute (these figures representing the extreme limits between which the output of the heart-pump may vary according to the condition of the body)? It might be thought that we are dealing here simply with the influence of the central nervous system, which adapts the activity of the muscles of the body to the requirements of the environment, and that the heart being a muscle would be stimulated to contract more strongly at the same time as the nervous system calls into activity the voluntary muscles of the body. There is no doubt that the heart is under the control of the central nervous system, so that its action can be altered, increased, or diminished by the brain in accordance with the needs of the economy, but in the heart we find also a wonderful power of adaptation to the varying requirements of the organism which is quite independent of the central nervous system.

This can be shown quite easily either in the cold-blooded or warm-blooded animal. The heart of the frog and tortoise can be cut out and will continue beating for hours or even days. It has long been known that the heart of the mammal would beat for some minutes after being cut out of the body, but if we take pains to ensure that the muscles constituting the walls of the heart continue to receive their supply of oxygenated blood, the mammalian heart can be made to beat for eight to twelve hours after the death of the animal from which it is taken. In order to investigate this properly we want to make such a preparation that we can control at will all the conditions which may affect the action of the heart—viz. the amount of blood flowing into the heart from the big veins, the resistance which the heart has to overcome when it drives the blood out into the arteries, and the temperature at which the heart contracts. We must be able to measure at any time the output of the heart, the arterial pressure it maintains, its changes in volume during contraction, the pressure in all its cavities during contraction, the amount of blood flowing through the blood vessels of its walls, and its chemical exchanges, as measured by the amount of oxygen which it takes up and the amount of carbonic acid which it produces. It is these chemical changes which give the energy for the work of the heart.

The Heart-Lung Preparation.

All these procedures and controls can be carried out in the heart-lung preparation. In this preparation the pulmonary circulation from right ventricle to left auricle is left intact, and by means of artificial respiration the lungs are blown up rhythmically so that the blood in its course may take up oxygen and get rid of carbonic acid. The whole systemic circulation is replaced by rubber tubes. A glass tube is tied into the largest branch of the aorta, all the other branches being tied, so that the blood driven out by the left ventricle can escape only by the glass tube. From the glass tube a rubber tube passes to a thin rubber tube container within a wide glass tube. This thin rubber tube can be compressed to any desired extent by pumping air at a known pressure into the glass tube

[1] Discourse delivered at the Royal Institution on Friday, May 20, 1921.

surrounding it. We can thus vary at pleasure the resistance which has to be overcome by the left ventricle, and, by maintaining a normal pressure in the beginning of the aorta, ensure a proper supply of oxygenated blood through the coronary arteries to the muscular tissue of the ventricles. It is this fact which makes it possible for the warm-blooded heart to continue to beat for eight to twelve hours after removal from the body. On the other side of the artificial resistance the blood is led through a spiral immersed in warm water to keep the blood at body temperature, and then passes into a reservoir from which a wide rubber tube leads to a glass tube placed in the big vein opening into the right auricle. By means of a screw clip on this tube the inflow of blood may be regulated to any desired extent, and can be kept constant while other conditions are varied. Thus in this preparation the three chief factors, temperature, the inflow of blood, and the resistance to the outflow of blood, can be varied separately and at the will of the operator. Any of the heart cavities or any part of the circuit can be connected to manometers so as to record the pressure of the fluid, and by means of a side tube placed just beyond the artificial resistance we can allow the blood to flow off into a graduated cylinder, and thus measure the time taken by the left ventricle to expel 50 or 100 c.c. of blood, thus measuring the average output of the organ.

An Experiment Described.

A typical experiment may be divided into six stages. Records of one experiment show that in the first stage the heart was beating at a normal rate (72 per minute), the blood pressure varied from 100 mm. Hg, and the output of the heart was 240 c.c. of blood per minute. In the second stage the resistance to the flow of blood through the tubes was increased to such an extent that the pressure rose to 160–180 mm. Hg. The heart continued to beat, and for a time put out just as much blood as it did at the lower pressure. In the third stage the artificial resistance was suddenly reduced to zero, the arterial pressure fell to about 20 mm. Hg, but the heart beat regularly and the outflow of blood was unaltered because the inflow of blood had not been altered. In the fourth stage the inflow of blood was raised suddenly to 600 c.c. per minute. The heart became bigger, but the regularity of its contractions remained unaltered, and it drove forward all the blood that it received.

The same thing happened in the fifth stage, in which the artificial resistance was raised simultaneously with the venous inflow. The reason for these phenomena is that within certain limits the heart isolated from the body can respond to all the demands made upon it; it can overcome a higher resistance, and it can pump out more fluid. In the sixth stage the inflow of blood was further increased to 1200 c.c. per minute, and the artificial resistance was increased until the blood pressure rose to 200 mm. Hg. This was too much for the heart, which began to beat irregularly and dilate widely. It would have failed altogether if the pressure surrounding the thin rubber tube had not then been released to allow the artificial pressure to drop to a level at which the left ventricle could empty itself.

If during this experiment the amount of oxygen taken up by the blood had been measured, and also the amount of carbonic acid given off by this fluid in passing through the lungs, an increase in both these amounts would have been found during the stage at which greater demands were being made on the heart. That is to say, the greater the work done by the heart, the greater the chemical changes to supply energy. A motor-car may be running steadily with an even beat of its engines along a level road; when it comes to a hill it will slow up and finally stop unless the chauffeur increases the chemical changes and the energy of each explosion within the cylinder by opening the throttle and letting in more mixture of petrol and air. In the case of the heart there is no chauffeur, but there is some automatic regulation by which the heart increases its chemical changes, and therefore the energy of each beat, in exact proportion to the work which is demanded of it. It is the nature of this automatic regulation which concerns us now.

The Nature of the Automatic Regulation of the Heart.

By a careful observation of the changes in the heart in the experiment described above we may arrive at some clue to the nature of the pressure, but more accurate methods are necessary if we are to be certain of the correctness of our guess. We must, under these varying conditions, measure: (1) the pressure in the heart cavities produced at each contraction; (2) the volume of the heart cavities—*i.e.* the length of the muscle fibres of their walls. The first we measured in the experiment described by connecting the interior of each cavity in turn with a quickly acting manometer, the excursions of which are registered by an optical method so as to avoid the instrumental vibrations of a lever. The curve of pressure obtained under two conditions—*i.e.* low and high artificial resistance—could then be plotted. It must be remembered that the heart was sending on in each case all the blood that it received, though the work necessary under the high pressure was two or three times as great as that necessary to send on the blood at the low pressure. To measure the volume of the heart the ventricles are enclosed in an instrument known as a cardiometer. This communicates with a piston recorder so that the change of the volume of the ventricles at each beat can be registered on a moving surface.

The question we have to decide is: How does the heart know when it is relaxed that at the next contraction it will have to exert more force than it did previously, when the arterial resistance to be overcome was lower? If we measure the pressure in the ventricles in the manner just described we find that during the period of relaxation of the ventricles the pressure in its cavities is approximately zero, whether the artificial pressure which it has to overcome at its next beat is 50 or 150 mm. Hg. It

is not, therefore, the tension on the walls of the heart which determines the strength of its contraction at its next beat. When, however, we come to measure the volume of the heart, we find that in the isolated heart this is directly proportioned to the work which the heart has to accomplish. Thus we find that the larger the heart—*i.e.* the more it is dilated during diastole—the greater is the pressure that it will get up at the succeeding contraction or systole.

We may put this in another form, as is shown by continuing our experiment over several hours, when we find that the worse the condition of the heart muscle, the more it must dilate in order to get up an adequate pressure. Other things remaining equal, we thus see that the volume of the heart during diastole is a measure of its physiological condition, and we are not surprised that a failing heart means a dilated heart. Of course there is a limit to this power of adaptation. As the heart dilates it is working at an ever-increasing mechanical disadvantage, and a point will finally arrive at which this disadvantage more than counterbalances the physiological effect of dilatation. The heart then dilates widely and fails to empty its contents. Dilatation of the heart means elongation of the muscular fibres composing its walls, so that we may put the law of the heart another way and say that the longer its muscle fibres the greater is the energy developed at each contraction. But in this form this wonderful power of adaptation possessed by the heart becomes part of the general properties of all muscular tissues, since the same rule applies to the fibres composing our voluntary muscles. Can we obtain any more precise and physiological conception of what is involved in this relationship between length of fibre and strength of contraction? Microscopic examination of the fibres, either of the heart or of voluntary muscle, shows that these are composed of innumerable fibrils, so that internally the muscle is made up of structures presenting an enormous extension of longitudinal surfaces. The more the muscle is stretched, the greater will be the extent of these surfaces. A large amount of evidence, based on the electrical and chemical changes occurring in muscle as a result of excitation, points to the contraction as being essentially a surface phenomenon—a molecular change over the whole of the longitudinal surface which may result in a polarisation or depolarisation of the surface and an increase of surface tension, so that the muscle is a surface tension machine in which there is on excitation a direct conversion of chemical into surface energy. The greater the surface the greater will be the number of molecules involved, so that increased length of muscle must increase at the same time the total chemical changes and the total tension produced by the summation of the surface tension of each fibril.

It is only by such a change of molecular dimensions that we can explain the rapidity of events in a muscle (the insect wing muscle can contract and relax 300 times per second), or the high efficiency of the machine, an efficiency which A. V. Hill has shown may amount to 100 per cent. for each isolated contraction, and over a length of time to 50 per cent. As directly measured in the heart-lung preparation, we find a mechanical efficiency of about 25–30 per cent.

Conclusion.

It is impossible here to enter into the applications of this law of the heart, but so far it has not failed in accounting for the behaviour of this organ under all manner of conditions, either in health or disease. It is important to remember, however, that we are dealing here with the isolated heart. In the natural body the mechanisms which we have studied are fenced round, protected and aided by the complex activity of the central nervous system, which is always acting on the heart, balancing its activity against that of the blood vessels, and co-ordinating it with the events which are occurring in every other part of the body. All these factors must be taken into account when we are endeavouring to form a conception of the total behaviour of this organ under the varying activities of the intact animal.

A Summer Visit to Jan Mayen Island.

By J. M. WORDIE.

JAN MAYEN ISLAND lies in 71° N. latitude, 8–9° W. longitude, and is approximately 300 miles north of Iceland, 200 east of Greenland, and 600 west and north-west respectively of Tromsö and Aalesund—the leading hunting ports in Norway. It was possibly discovered in 1607 by Henry Hudson and named "Hudson's Tutches"; the name, nevertheless, by which it is now known commemorates a Dutch seaman, Jan Jacobsz May, who visited the island in 1614. The evidence for the earlier visit by Hudson can scarcely be regarded as trustworthy. May's voyage, on the other hand, is well supported by documentary evidence. Immediately following its discovery, Jan Mayen became frequented almost every year by rival Dutch and British whalers. As a whaling and sealing centre, however, the island was markedly inferior to Spitsbergen. Its importance was, nevertheless, far from small, and the British Government is said to have made a grant of it to the Corporation of Hull in 1618. The number of whalers frequenting the island, however, dropped off very considerably about 1635, the immediate cause being probably a series of bad ice years.

Scoresby was the first to give a scientific account of the island. His narrative was based on a visit in 1817, when he was ashore for a short while and climbed one of the smaller extinct craters. Berna and Vogt in 1861, Mohn in 1877, and Rabot in 1892 also published descriptions. The only expedition last century which remained any length of time on the island, however, was that of the Austrian International Circumpolar Station in 1882–83. During a fourteen months' stay under Wohlgemuth's leadership the party made full magnetic and meteorological records. Their map, which we found very useful and accurate, was the work of von Bobrik. Curiously enough, the natural history was very slightly studied.

station for meteorological purposes either last year or this. A satisfactory arrangement was made, and our expedition secured passages in Engineer Ekerold's two ships *Polarfront* (24 tons) and *Isfuglen* (54 tons). On the Norwegian side the affair was now pushed with greater vigour than ever, and after innumerable difficulties Ekerold finally was able to carry his plans into execution.

At Bergen we were met by Prof. Mercanton, of Lausanne, who had long wished to climb the mountain, and it was arranged that on reaching the island he should transfer from the Norwegian party to ours. We were now strongly represented in the various branches of science. Musters himself undertook botanical collections, Bristowe and Leth-

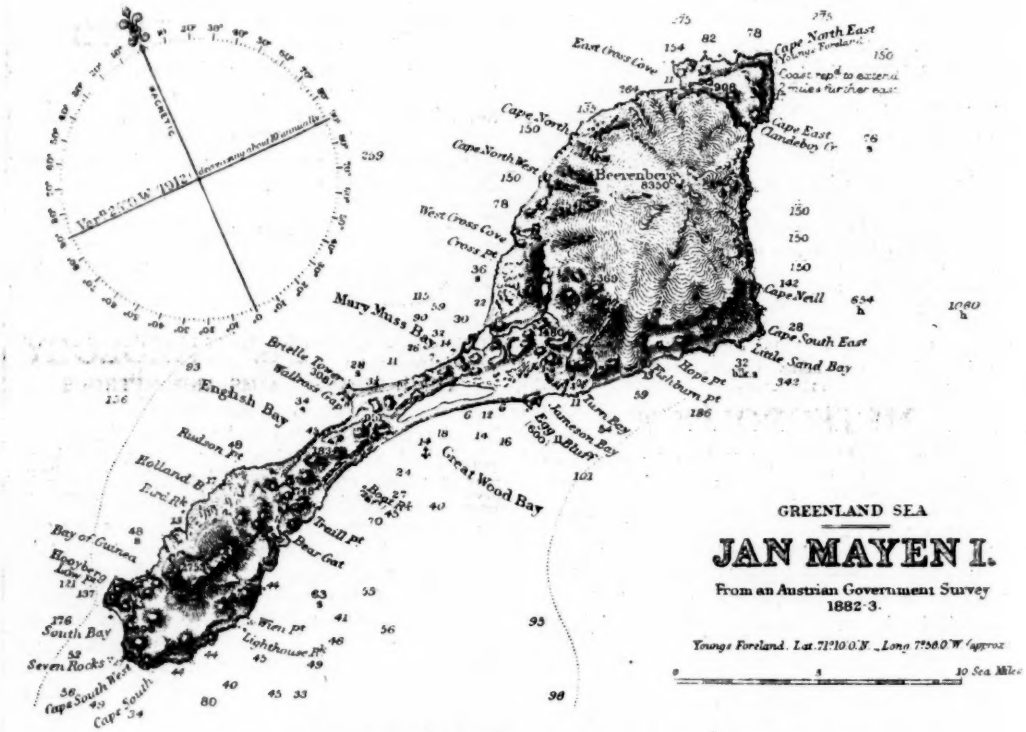


FIG. 1.—Reproduced, by permission of the Hydrographer, from an inset on British Admiralty Chart No. 2751.

Last summer's expedition was originated by J. L. Chaworth-Musters at the beginning of last year; the objects were partly to climb Beerenberg, a mountain more than 8000 ft. high, and often stated to be a still active volcano, partly to complete the Austrian survey of the island by investigating more minutely its geology and natural history. Musters originally intended to charter a hunting sloop from Aalesund. This, however, proved unnecessary through the establishment of friendly relations with a Norwegian engineer, who, under the auspices of the Norwegian Government, was hoping to establish a wireless

bridge the natural history, and Mercanton's knowledge of glaciology and mountaineering made him a valuable recruit. The party of six was completed by Richmond Brown as "campman," and myself as geologist. Four of us were members of Cambridge University.

After a somewhat rough passage the island was reached on August 7. It was much too late to think of studying the nesting habits of the birds. It was almost too late to find the plants still in flower. Musters, therefore, accompanied by Bristowe, at once commenced his collecting. The lateness of the

season also made it advisable immediately to attack the hitherto unclimbed Beerenberg. To make the ascent direct from sea-level seemed hardly practicable, and an advance camp was, therefore, established at 2700 ft. on the highest of the frontal moraines. Unfortunately, Brown was not well enough to go farther, and the size of the party was thus reduced to three. Starting on August 11 about 11 a.m., for there had been some rain during the night, we trudged for some hours up a gently sloping and but little-crevassed ice-slope to a nunatak at a height of 5600 ft. The real climb now began. Mercanton went first, Lethbridge second, with myself as last man. Two thousand feet of interesting snow- and ice-work brought us finally to the bergschrund not far below the ridge, and after a little delay it was safely negotiated. A stiff climb up a steep snow-wall then brought us to the ridge, and we suddenly found ourselves standing on the rim of a great crater. This was an unexpected and exciting development. The crater was about half-a-mile in diameter, and from 500 to 800 ft. deep. At its northern edge one of the later eruptions had burst the rim and formed a gateway of which the highest part of the mountain is now the western pillar. Since that distant period, however, the crater has become filled with ice, and a much-crevassed glacier now breaks away to the north in a series of striking icefalls, finally reaching the sea (so Mercanton afterwards informed me) as the Weyprecht Glacier. To complete the ascent by following a snow-arête to the actual summit was not long of accomplishment, and gave us a further opportunity of appreciating Mercanton's mountaineering skill. That the summit, deep-covered in rime as it is, has solid rock not far below is certain; scoriaceous lava was collected 50 ft. away. Observations on the summit occupied some time, and, fortunately, there were bursts of sunshine sufficient to enable photographs to be taken. It was almost 9 p.m., therefore, before we commenced the return, but a brisk pace was kept up, and a distance which had taken eight hours on the ascent was now covered in three.

Apart from the geological observations, which showed that the Beerenberg eruptions had been exclusively lava, quite the most interesting and perplexing feature is the gentle ice-slope extending from 5600 ft. down to the camp at 2700 ft. Viewed from a distance, it has all the appearance of an "ice-cap"; it reminded one very closely of the Hardanger Jökul, for instance. At the time I was inclined to regard it as a new type of piedmont or as an "ice-cap" caused by higher precipitation at intermediate levels. It may be so, but, on the other hand, since returning I have noticed that a similar gentle slope characterises both Mount Vesuvius and Mount Erebus, and it can, therefore, be explained on other grounds. Aneroid observations were taken at regular intervals during the ascent. These give Beerenberg a height of 8090 ft. The Austrian figure arrived at by theodolite observations was 8350 ft. It is not usual to prefer aneroid- to theodolite-determined heights, but as the Austrian triangle was a very bad one I think there may be some justification in this case for adopting a lower figure than that generally accepted.

Whilst the mountain was being climbed, Musters and Bristowe had been working at lower levels. After hurried preliminary collections round the base camp they transferred their quarters to a small tent eight miles farther down the coast. From this point the southerly parts were within reach. Musters records a most interesting visit to Seven Hollander Bay, interesting not only historically, but also botanically in respect of the more luxuriant vegetation in that quarter. When Musters finally left the island he was able to tabulate forty-three species of flowering plants, of which five had not previously been recorded there; in addition, the lower orders have still to be worked out and his ecological observations put together. The collections have an added interest just now, as they arrived at the Cambridge Botany School simultaneously with collections made last summer by Prof. Seward in West Greenland, and by Mr. Walton in Spitsbergen. Bristowe's insects are taking longer to name; meantime he has discovered that the spiders are forms met with in the Scottish Highlands; of the flies, etc., only one is native to Britain; the rest are not yet identified. Seventy per cent. of his specimens are new records for the island.

The successful climb on Beerenberg had revealed a good deal about the geology and glaciology. We realised, however, that on that mountain we were dealing with comparatively recent events in the island's history, and the older chapters, if any, had to be discovered. Lethbridge and the present writer in due course relieved Musters and Bristowe at the tent at the south end. From here we ranged over the more distant and inaccessible parts. Apart from the distances which had to be covered, it was arduous travelling both along the coast and on the scree-covered mountain slopes. As the survey was not absolutely exhaustive, additional data may still come to light; meantime the geological record is somewhat as follows: The oldest rocks are coarse and fine augite tuffs; they are generally covered and hidden by later lavas, but are occasionally seen forming rugged and picturesque cliffs along the coast. The earliest lavas were biotite-trachyte; rocks of this composition are nowhere found at craters still well preserved, but always as old hill features. The other and later distinctive lava type is an olivine-augite-basalt rich in alkalis. This rock is found at all the recent craters and also at many older, half-obliterated centres of eruption. A rock of much the same composition, but varying in details, has a wide-spread occurrence in the form of sills. The south end of the island consists of the older volcanoes; Beerenberg, at the north end, however, must be one of the latest, and round its foot there are many subsidiary cones—*e.g.* Palffy and Vogt craters, which must also be of comparatively recent date. These are exclusively lava craters. One of the very latest, however, is an ash cone—Egg Bluff; it has

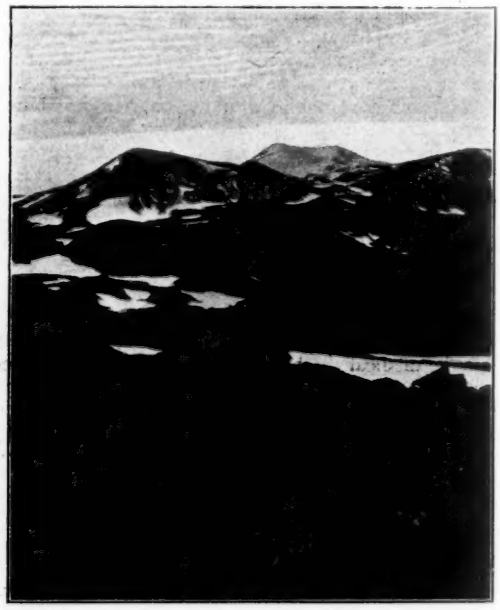
a further interest because on the summit there are a few short irregular cracks from which hot steam still issues. Under certain atmospheric conditions these cracks "smoke" quite obviously and this phenomenon was possibly the "eruption" reported by Scoresby in 1818. Scoresby's account is unfortunately written with considerable hesitation. "Smoke" on Egg Bluff scarcely satisfies his description, however. It seems more probable that an ash eruption actually took place at the foot of the western side of Vogt (Scoresby's Esk) crater, possibly in the same spot where the only other authentic eruption, that of 1732, was observed by the whaler, J. J. Laab. Beerenberg itself has never been observed in activity. There is no evidence of when the first eruptions took place; they may even be post-glacial.

Photo] [W. S. Bristowe

FIG. 2.—Beerenberg from the south.

As regards glaciology, Prof. Mercanton has supplied me with a brief summary. Glaciers are confined to Beerenberg. Four elements are distinguished: (*a*) the glacier which issues from Beerenberg crater; (*b*) a "collerette glaciaire," continuous in its middle portion, covering the north and north-east parts of the mountain; (*c*) an independent system on the eastern flanks; (*d*) a great "collerette" covering the flanks from north round through west and south to east-south-east. (Part of the latter has already been referred to as the ice-cap feature.) The examination of these different elements shows decreasing glaciation, but whether recent or ancient has not yet been discovered. The rate of movement recorded shows the same order of things as on similar decreasing glaciers in Switzerland. More exact figures, however, will be available when the ground is re-visited.

By the beginning of September it was obvious that the work was now practically complete. Winter weather had already set in, but we were told that we might still make a fair passage. We left the island in *Polarfront* on September 3. *Isfuglen*, however, was remaining another fourteen days in order to bring home the men working at the erection of the wireless station. This they soon completed, and the first message had already reached Norway when we made the coastal waters on September 9. Engineer Ekerold has therefore put up a weather station in a spot where it will be of real value—in the "blind corner" whence no weather warnings had previously been available. He did so under the most difficult and unsuitable conditions. The work involved the unloading of delicate machines from small boats on an unprotected surf-ridden coast, the overcoming of the difficulties of transport to the site selected, and finally the raising of the masts in adverse wind conditions, and fixing them in frozen ground. Ekerold is now sending daily weather reports to Norway. With the assistance of these it is hoped that it will be possible to forecast the arrival of the northerly and north-westerly gales which come down so suddenly all along the Scandinavian coast, and thus to warn the Norwegian coastal shipping, which has suffered so heavily in the past from the unexpected gales from that "blind corner."



Photo] [W. S. Bristowe

FIG. 3.—Mountains at south end of Jan Mayen.

Obituary.

SIR GERMAN SIMS WOODHEAD, K.B.E.

WE regret to record the death of Sir German Sims Woodhead, professor of pathology in the University of Cambridge, which occurred suddenly on December 29. At the commencement of the war Prof. Woodhead was mobilised and became a colonel in the R.A.M.C. (T.), and was for some time head of a camp in Tipperary. He afterwards was appointed inspector of laboratories in the military hospitals in the United Kingdom, a post which involved perpetual travelling and discomfort, the strain of which no doubt conduced to the signs of serious over-work from which of late he suffered. In 1919 he was created K.B.E. in recognition of his valuable war work.

Born in 1855, Woodhead was educated at Huddersfield College, whence he entered the medical faculty of the University of Edinburgh, graduating in 1878. He then spent some time on the Continent, studying in Berlin and Vienna. In 1887 he was appointed superintendent of the research laboratories of the Royal College of Physicians, Edinburgh, resigning this post in 1890 on his appointment as director of the conjoint laboratories of the Royal Colleges of Physicians and Surgeons in London, which he held until his election in 1899 to the chair of pathology in the University of Cambridge in succession to the late Prof. Kanthack. Here it was largely due to his initiative and energy that the new medical school buildings were erected, including the memorial museum to Sir George Humphry.

Woodhead's activities were manifold and untiring; he was a strong supporter of the temperance movement, and was president of both the British Medical Temperance Association and the British Temperance League. He was an hon. LL.D. of Birmingham and Toronto Universities, fellow of Trinity Hall, Cambridge, hon. fellow of the Henry Phipps Institute, Philadelphia, member of the Executive Committee of the Imperial Cancer Research Fund and of the Scottish Universities Committee, and past-president of the Royal Physical Society, Edin. (1878), and of the Royal Microscopical Society (1913–16). It can scarcely be doubted that, had he attempted less, his output of original work in his own special department would have been greater.

Woodhead published in 1883 "Practical Pathology," which reached a fourth edition in 1910; in 1885, "Pathological Mycology" (with Hare); and in 1891, "Bacteria and their Products." He was founder of, and for many years conducted, the *Journal of Pathology and Bacteriology*. In 1894 he published with Dr. Cartwright Wood an investigation on the efficiency of domestic water filters, and during the war devised a method for the chlorination of drinking water. While director of the conjoint laboratories he published a report on diphtheria for the Metropolitan Asylums Board, and devoted much attention to the standardisation of diphtheria antitoxin. Tuberculosis was also a subject to which Woodhead devoted much attention. He drew up a report to the Royal Commission on Tuberculosis in 1895, and was a member of the Royal Commission on Tuberculosis of 1902. Just before the war he devised an apparatus for the continuous record of the temperature of animals, and published the results of investigations obtained by it. Of late the subject of colonies for the tuberculous occupied much of his time, and he was joint author of "Settlements for the Tuberculous." Woodhead was of a genial and kindly disposition, and he will be greatly missed by a large circle of friends and acquaintances. R. T. H.

PROF. G. S. BRADY, F.R.S.

PROF. GEORGE STEWARDSON BRADY was born in Gateshead on April 18, 1832. His father, Henry Brady, was a surgeon, and he himself was trained for the same career. He was a student of the University of Durham College of Medicine, Newcastle-upon-Tyne, and practised in Sunderland from 1857 to 1906. During the greater part of this period Prof. Brady was also professor of natural history in the University of Durham College of Science, now Armstrong College, Newcastle-upon-Tyne. He began his duties as professor in 1875, and on his retirement in 1906 was elected honorary professor of natural history. In 1906 he went to live in Sheffield, and died there on December 25 last.

Both Prof. Brady and his brother, H. B. Brady, were early interested in natural history, and it is worth remarking that during the time Prof. Brady was studying medicine Tuffen West was an apprentice to his father. All three afterwards attained distinction, Tuffen West as a naturalist artist, H. B. Brady as an eminent authority on Foraminifera, and Prof. Brady for his work on Crustacea, especially on Entomostraca.

Prof. Brady became a member of the Tyneside Naturalists' Field Club in 1849, not long after its inception as a branch of the Natural History Society. He was president in 1871 and again in 1892–93, and he contributed many papers to the Transactions of the Natural History Society. His early papers dealt with algæ and other plant groups, but it was not long before he determined to devote himself to Crustacea and especially to Copepoda and Ostracoda. This work was his hobby, and he devoted his spare time to gathering and to examining his own collections and collections sent to him. The results have been published in a long series of papers, and these brought him into intimate relationship with other workers in the same field here and abroad. But he advanced into a place of prominence when he described the *Challenger* collections of Copepoda and Ostracoda. His reputation was further enhanced when his work on the free and semi-parasitic Copepoda of the British Islands was published by the Ray Society. With the late

Canon Norman he published a monograph of the Ostracoda of the North Atlantic and North-western Europe, and also a catalogue of the Crustacea of Northumberland and Durham.

Prof. Brady's scientific work was done at home. Although he restricted his publications mainly to the results of his examination of Entomostraca from collections made in this and other countries—notably Australia and South Africa—his characteristically neat preparations show that he had interests in all groups which came into the field of his microscope. He was a pioneer in marine dredging, and took an active part in the Northumberland excursions of the early 'sixties, and in the 'nineties he was as keen as before.

It was a pleasure to know Prof. Brady, to be his friend, to watch him work and hear him talk on men and things, on politics and related subjects, and those who had not this privilege will find from his addresses to the Tyneside Naturalists' Club that he gave a critical and well-thought-out consideration to the important questions which arose during his long life and that he had decided opinions and was fearless in expressing them. A. M.

Notes.

WE are particularly glad to see the names of Prof. C. S. Sherrington and Prof. W. A. Herdman in the list of New Year honours. Prof. Sherrington, who has been appointed a Knight Grand Cross of the Order of the British Empire (G.B.E.), is the president of the Royal Society, and is to be president of the British Association for the meeting to be held in Hull in September next; and Prof. Herdman, who has received the honour of knighthood, vacated the presidential chair at the Edinburgh meeting last year. The two leading British scientific organisations are thus most appropriately represented in the honours list. Other honours included in the list are:—*Knighthoods:* Prof. G. E. Cory, professor of chemistry, Rhodes University College, Grahamstown; Dr. G. S. Buchanan, Senior Medical Officer Ministry of Health; and Dr. J. H. Parsons, F.R.S. *K.C.I.E.:* Sir John Biles, professor of naval architecture, University of Glasgow. *C.M.G.:* Dr. R. T. Paton, Director-General of Public Health and President of the Board of Health, New South Wales.

THIS week we begin the publication of a Calendar of Industrial Pioneers, which is intended to supplement the Calendar of Scientific Pioneers which appeared in our columns last year. It is not necessary here to point out the close association that exists between scientific discovery and industrial progress. The two are inseparable. Problems of communication, transport, mining, agriculture, and manufacture depend for their solution on the co-operation of the laboratory and the works. We believe, therefore, that our readers will welcome the series of biographical notes which will recall the great engineers, inventors, manufacturers, and captains of industry who, by the application of the discoveries of the pioneers of science, have extended existing industries, created new ones, or in some other way contributed to the advancement of civilisation.

A CONFERENCE which commenced on December 12 last was held by permission of the Government at the Ministry of Health, at which delegates from the Health Committee of the League of Nations discussed the international standardisation of therapeutic serums and the sero-diagnosis of syphilis. Prof. Madsen, of Denmark, presided, and Austria, Belgium, France, Germany, Italy, Japan, Poland, Switzerland, Great Britain, and the British Ministry of Health, the War Office, and the Medical Research Council were represented, and the business was conducted by sub-committees. As regards diphtheria and tetanus antitoxins, it was considered both possible and desirable that international units should be fixed for these serums, and a scheme of work to establish them was drawn up. As regards anti-meningococcic, anti-pneumococcic, and anti-dysentery serums, various criticisms were made of the present technique for standardising these, and a scheme of new investigations to obtain more uniformity was adopted. As regards the sero-diagnosis of syphilis, a scheme for comparing the results obtained by the Wassermann reaction with those of other methods was drawn up. An official luncheon was given by the Government to the delegates and guests, at which Sir Alfred Mond presided. It is understood that the conference will meet again in six months' time, probably at the Pasteur Institute, Paris, to report progress and to make further recommendations.

THE *Times* of December 24 published a telegram from Delhi announcing that Mrs. Aidie, who is the widow of the late Lt.-Col. Aidie, I.M.S., has discovered a parasite in the salivary glands of the bed-bug, which is probably a stage of the *Leishmania Donovani* parasite of kala-azar. If this important discovery is confirmed it will furnish the final proof of the truth of the theory of Sir Leonard Rogers that the common bed-bug is the carrier of the infection. The human stage of the parasite was first described by Sir William Leishman in 1903, and was found independently by Lt.-Col. Donovan, I.M.S., while in 1904 Rogers cultivated the organism *in vitro* and discovered the flagellate stage of the parasite. In the following year he recorded experiments showing that sterility and a neutral or slightly acid medium, such as he found in the stomach of bed-bugs, were most suitable for this development, while the plan he had advised as early as 1897, of moving healthy coolies out of infected into new lines only a few hundred yards away, had proved so successful in eradicating the disease from tea estates that the infecting agent was not likely to be a flying one, and he pointed out that infection through the ubiquitous bed-bug would explain all the known facts. Major Patton, I.M.S., in Madras next obtained the development of the flagellate stage of the parasite in the

guts of bed-bugs, and certain forms believed to be a post-flagellate stage have since been described by Cornwall, Knowles, and others, but the ultimate development and exact mode of infection have hitherto eluded all workers. Mrs. Aidie has worked for a long time at the Pasteur Institute in Shillong with Major Knowles, I.M.S., so there is every reason to hope that the recent announcement will soon be confirmed. Whether it will help much in dealing with the disease is open to doubt, for long ago Dr. Dodds Price carried out Rogers's suggestion to try to destroy bed-bugs in infected coolie huts in Assam, but without much success, while such very good results in dealing with kala-azar by the tartar emetic treatment are now being obtained in Assam that a vigorous campaign on those lines may be expected practically to stamp out the disease within a few years.

THE following have been elected officers of the third International Congress of the History of Medicine to be held in London on July 17–22 next:—*President of Honour:* Sir Norman Moore, Bart. *President:* Dr. Charles Singer. *Vice-Presidents:* Sir D'Arcy Power and the presidents of the first two congresses, Dr. Tricot-Royer, of Antwerp, and Drs. Jeanselme and Menetrier, of Paris. *Treasurer:* Mr. W. G. Spencer. *General Secretary:* Dr. J. D. Rolleston.

H.S.H. PRINCE ALBERT OF MONACO and Prof. G. O. Sars, of Christiania, were elected foreign members of the Zoological Society of London at its monthly meeting on December 21. The secretary reported that there had been 221 additions to the society's menagerie during November, 104 by presentation, 66 deposited, 5 received in exchange, 44 by purchase, and 2 by birth. The gifts included four lions born in India, presented by the Jam Sahib of Nawanagar. The number of visitors to the gardens during November was nearly seven thousand fewer than during the corresponding month of 1920.

THE annual meeting of the British Medical Association will be held in the University buildings at Glasgow on July 21–28 next. The first three days of the meeting will be taken up by the annual representative meeting, and in the evening of July 25 the new president, Sir William Macewen, will deliver his presidential address. The remaining three days of the meeting will be devoted to scientific and clinical work. Papers and discussions are being arranged for the morning sessions and clinical and laboratory demonstrations for the afternoons. The scientific proceedings of the meeting will be distributed among nineteen sections, each dealing with a particular branch of medicine. In the evening of July 28 a popular lecture will be delivered by Prof. J. Graham Kerr.

AT the next ordinary scientific meeting of the Chemical Society, to be held on January 19, at 8 p.m., Prof. Arthur Smithells will give an account of Langmuir's theory of atomic structure, and will exhibit models. In connection with Sir Ernest Rutherford's lecture on "Artificial Disintegration of Elements," to be given before the Chemical Society on Thursday, February 9, at 8 p.m., it has been decided that visitors will be admitted by ticket only. Fellows of the society will not need tickets for themselves, but those desiring to bring visitors should apply for tickets to the Assistant Secretary, Chemical Society, Burlington House, W.1, not later than January 28. No fellow will be allowed more than two tickets. The lecture will be delivered in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1.

AN exhibition of industrial heating apparatus, to be held in April of this year, is being organised by the Office Central de Chauffe Rationnelle, Paris, under the patronage of the Société d'Encouragement à l'Industrie Nationale and the Société des Ingénieurs Civils de France. The exhibition will comprise apparatus and material connected with "la conservation et la récupération" of heat, and it will be divided into two sections, one including refractory materials, insulators, etc., and the other apparatus and plant, such as economisers, heat-recovery plants, etc. Every facility will be given for experimental demonstrations of exhibits. Further information may be obtained from M. L'Ingénieur Directeur de l'Office Central de Chauffe Rationnelle, 5 Rue Michel-Ange, Paris, XVI. We are informed that the director will be glad to receive applications to exhibit from British manufacturers.

AT a meeting of the Royal Statistical Society on December 20, Mr. E. A. Rusher read a paper dealing with the statistics of industrial morbidity in Great Britain. From a review of investigations on this subject for the past one hundred years, he concludes that (1) age has the greatest influence upon the rate of sickness, and next to this, occupation; (2) occupation has more influence than has either locality or density of population, but the influence of the latter cannot generally be statistically dissociated from that due to occupation; (3) there are no trustworthy statistics in this country of morbidity among female lives; (4) no statistics exist of the sickness experienced by the community at large corresponding to those for mortality published by the Registrar-General. Mr. Rusher advocated a systematic attempt to investigate the data now available through the operations of approved societies under the National Insurance Acts in order to obtain some measure of occupational incidence of sickness analysed into classes of disease.

COL. T. C. HODSON writes in amplification of our condensed report of his remarks in the discussion which took place at the Royal Anthropological Institute on Prof. Elliot Smith's paper on "The Mound-Builders of Dunstable" (see NATURE of December 15 last, p. 512) to point out in reference to the distinct forms of disposal of the dead associated with the mounds, viz. (1) burial of a woman and child in a flexed position and (2) cremation, that in India many living races have two—in one case four—different modes of disposing of the dead, varying according to (*a*) cause of death and (*b*) social status of the dead. Col. Hodson also points out that one of the elemental features of Jhum cultivation in Assam is the use of logs of burnt

trees as retaining walls to hold up the soil and keep in the moisture, and that Mr. Mills's reference to ignorance of the proper ceremonial as a reason alleged for not adopting terrace cultivation throws an interesting light upon the possibilities of the negative aspect of the evidence with regard to this method of cultivation.

In an elaborate paper published in the Journal of the Royal Institute of British Architects (third series, vol. 28, No. 3, October, 1921) Mr. Jay Hambridge supplies "Further Evidence for Dynamic Symmetry in Ancient Architecture." The paper gives a careful series of measurements of the Parthenon and other Greek temples which are of permanent value. The writer remarks: "The temple at Aegina is older than the Parthenon, older than the Zeus building at Olympia; therefore the finding of a persistent dynamic theme in the structure which is simply a variation of the themes at Bassæ, Olympia, and Athens suggests that symmetry schemes had some sort of ritual significance. And this is borne out by the record from India. About the time of the erection of the Greek temples of the best period, if not somewhat earlier, there existed in India specific rules for sacrificial altar construction. These have survived as the Sulvasutra, or 'rules of the cord,' better, 'rules of the rope.' Some authorities date the Sulvasutra about 800 B.C., others place it at 600, 500, 400, and even 200 B.C. The exact date is immaterial, as the point of importance for us is that these rules describe in detail the construction of the root rectangles which constitute the base of classic Greek proportion."

The year which has just closed will long be remembered for its shortage of rainfall over the British Isles, as well as in many other parts of Europe. At Greenwich Observatory, where records are available for more than a hundred years, there is no previous year since 1815 with so small an amount of rain. In 1921 the total measurement for the twelve months was 12·50 in., which compared with the average 24·41 in. for the hundred years from 1816–1915 is only 51 per cent. of the normal, and compared with the normal for thirty-five years, 1881–1915, in use by the Meteorological Office, viz. 23·50 in., is 53 per cent. of the normal. Compared with the one hundred years' normal, the rainfall in each month was less than the average, but compared with the normal for thirty-five years, January and September had slightly more rain than the average. The month with least rainfall was February, with 0·12 in., followed by July with 0·15 in. In the previous 106 years the year of least rainfall was 1864 with 16·38 in., and this is followed by 1847 with 17·61 in., and 1858 with 17·70 in. The rainfall for the eleven months to the end of November was 68 per cent. of the average in England and Wales, 94 per cent. in Scotland, and 86 per cent. in Ireland. At Tenterden, as representative of Kent, the rainfall for the eleven months to the end of November was 49 per cent. of the average; at Arundel, as representative of Sussex, 53 per cent., and at Oxford 59 per cent. Notwithstanding the wild and unsettled character of the weather at the close of the year droughty conditions continued in the south and south-east of England.

The annual report of the Gresham's School, Holt, Natural History Society for 1921 includes a useful list of the flowering plants found in the neighbourhood of Holt, Norfolk, the work of the botanical section, and a preliminary list of the Hemiptera-Heteroptera of the same district, compiled by the entomological section.

In the *Quarterly Journal of Microscopical Science* (vol. 65, part 4), Prof. Champy and Mr. H. M. Carleton discuss the shape of the nucleus and the various mechanical causes, such as surface tension and the pressure of cytoplasmic inclusions, by which it is determined. They come to the conclusion that the amitotic division which occurs in certain highly specialised nuclei results from the attainment by the nucleus of a degree of differentiation that is incompatible with mitosis.

To the few known cases of flagellate protozoa with trichocysts another has been added by the observations of Dr. W. Conrad, who has found trichocysts in *Reckertia sagittifera*, n.g., n.sp., a colourless Chloromoradine found in an aquarium in the Botanic Garden in Brussels (Bull. Acad. Roy. de Belgique, Classe des Sciences, 1920, No. 11). The organism is about 50 microns in length, and has two flagella, one directed anteriorly and the other posteriorly. In addition to swimming by means of the flagella, the organism can creep by means of blunt pseudopodia, about six in number, which serve also for the capture of food, such as bacteria, flagellates, and algal zoospores. A layer of slender, rod-like trichocysts in the ectoplasm gives this region a fine and regular striation. Trichocysts are not present in the pseudopodia. Close to the insertion of the flagella are two lateral contractile vacuoles which contract alternately and discharge their contents into a median apical vacuole. Food vacuoles, similar in their reaction to neutral red to those of Paramecium, are present in the endoplasm. The nucleus is of the vesicular type, and divides by karyokinesis; cell division is, as usual in flagellates, longitudinal.

The story of Lord Howe Island as told by Mr. Allan R. McCulloch in the *Australian Museum Magazine* (vol. 1, No. 2) is a sad one for the naturalist. Situated three hundred miles to the east of Australia, it was uninhabited by man when discovered in 1788, and, having no indigenous mammals or reptiles, was the home of a vast and interesting bird population which, ignorant of the murderous ways of man, knew not how to protect itself from his ravages. One species, *Notornis alba*, unable to fly, quickly became extinct, and, except for one skin in the Vienna Museum and a few stray notes in journals, nothing is known of this interesting bird. The island is a dependency of New South Wales, and in 1879 was declared a reserve in the hope that what then remained of its fauna would be preserved. Success seemed to have rewarded this excellent measure,

but unfortunately rats were accidentally introduced into the island, and the birds' paradise of two years ago has been reduced to a veritable wilderness beyond all hope of recovery. Mr. McCulloch's account of this tragedy is accompanied by excellent photographs and an interesting description of the natural history of the island, with valuable notes on some of the more interesting birds—magpies, woodhens, and muttonbirds.

IN the *Journal of the Federated Malay States Museums* (vol. 10, part 3, June 1921), Major J. C. Moulton publishes the first of a series of articles on Malaysian butterflies, designed to supplement or correct the information of this region given in Seitz's "Macrolepidoptera of the World." The author defines a true Malaysian sub-region as distinct from a wider area, in which a non-Malaysian element is evident, though not necessarily predominant, and defines it as between lat. 10° N., and 10° S., and long. 95° E. and 120° E., thus including the Malay Peninsula, Borneo, Sumatra, and Java, with its adjacent islands. Thirteen new forms and combinations are described. Major Moulton continues the innovations introduced into his earlier papers of printing the sub-specific names in less prominent type than the generic and specific names, and of retaining the author's name for a species even when followed by a sub-specific name. Both courses have since received the approval of the British Association Committee on Zoological Nomenclature. Valuable notes on variations and geographical distribution are given, accompanied by useful keys for the discrimination of species, subspecies, and forms. We may specially note the distinction drawn by the author between "sub-species" and "forms"—the former as geographical races inhabiting separate areas, and the latter as well-defined forms occurring together over a wide range of country.

THE difficult question of the drainage of the Vale of Pewsey, a district now so well known to the aviators of Upavon, is dealt with by Mr. W. D. Varney in the Proceedings of the Geologists' Association, vol. 37, p. 189, 1921. The vale seems to have been excavated originally along the Pewsey anticline of Cretaceous rocks, which provided a line of weakness, by a river flowing eastward from the Cotswolds and escaping southward by the present gap of the Avon, the river that passes through Salisbury to the sea at Christchurch. This stream was beheaded during the growth of the Severn valley, when the other Avon of the district, which flows through Bristol, was working its head backwards and capturing in addition some of the head-waters of the Kennet and the Thames. Mr. Varney's sketch-maps indicate also the recession of the southern coastline and the formation of the Isle of Wight.

IN a lengthy and most instructive article in the *Geographical Review* for October last on the distribution of population Mr. M. Aurousseau directs attention to the fact that three kinds of maps which at present do not exist are much wanted and could be compiled by the geographical survey of countries. The earth-material map would show the following features: Areas of deep drift soils, areas of residual soils, hydrographical information, fuel deposits, and the location and nature of metallic ores and other economic deposits. The power map should show the distribution of the different power resources—wood, wind, water, coal, oil, etc. Finally, the lowlands map would be a topographical map so coloured that the lowlands, even when of small areas as in the case of intermontane deposits, would stand out prominently. Mr. Aurousseau also points out that in taking stock of the world's resources we require to know the expansion ratio of every land—that is to say, the ratio of the extent to which a given area is occupied to the extent to which it may be occupied. He sketches the nature of the geographical survey required in order that this ratio may be obtained.

AN interesting paper on Greek and Roman engineering instruments, read before the Newcomen Society on December 15 last by Mr. R. C. Skyring Walters, illustrates the uses of historical research applied to science. Such research, the product of co-operation between classical scholars and men of science, was also exemplified at a joint meeting of the Textile Institute with the Manchester and District Branch of the Classical Association and Literary and Philosophical Society last November, and it cannot fail to be of great usefulness. In his paper Mr. Walters quotes the description by Vitruvius of the use of the *dioptra, chorabates*, and water levels in surveying by the Greeks and Romans up to about 100 A.D., and he gives sectional drawings showing reconstructions of these instruments, of which no complete example remains. The *groma*, an arrangement of two crossed arms at right angles with suspended plumb lines at the ends, used for setting out straight lines and lines at right angles, is also shown. In the case of the *dioptra* the advanced stage of development in constructive detail which was reached at the time of Hero of Alexandria, is remarkable. The conclusion is that there are many striking points of similarity, not only in the instruments, but also in the methods employed 2000 years ago, with those of the present day.

WE have received an advance copy of a Carnegie Research Memoir published by the Iron and Steel Institute on the constitution of chromium steels by Mr. T. F. Russell. During recent years industrial applications of iron-carbon-chromium alloys have increased, and a paper on this subject, therefore, is welcome. It must be confessed, however, that the present one does not do much to advance our knowledge of chromium steels. The author has confined himself to an examination of a very restricted area of the iron-carbon-chromium ternary system, in which the carbon does not exceed 1 per cent., while the limit of chromium is 12 per cent. It would have been better if he had taken into consideration in the first instance the equilibrium conditions observed in the binary systems iron-carbon, chromium-carbon, and iron-chromium. Without this a scientific interpretation

of the effects observed in the ternary system is impossible. It follows, therefore, that many of the data obtained are as yet purely empirical.

We learn from the *Times* of December 27 that Major Klein is at work on a three-colour printing process in which the chief innovation is in the taking of the colour records. Instead of the usual light-filters attached to the camera he illuminates the object with light of the desired colour obtained by the well-known method of cutting off with opaque screens the light not wanted in a spectrum produced by suitable spectroscopic apparatus. It seems that he proposes to try the effect of reducing the width of the utilised portions of the spectrum so as to get a nearer approach to monochromatic light, and also the division of the spectrum into more than three parts for four or five, etc., colour processes.

In the December issue of the Journal of the Society of Chemical Industry Dr. G. C Clayton contributes an interesting summary of the effect of the war on the heavy chemical industry. The Leblanc soda industry is stated to be obsolete, and many of the by-products formerly obtained by it have now to be prepared by other methods. One of the main products, caustic soda, is now made either from ammonia-soda carbonate or by electrolysis. The two chief electrolytic processes operated in this country are the mercury process, by the Castner-Kellner Co., and the Gibbs diaphragm process, by the United Alkali Co. In the manufacture of chlorine the Weldon and Deacon processes have been displaced by the electrolytic methods. Electrolytic chlorine is produced by the Castner-Kellner, Gibbs, and Hargreaves cells, and is often liquefied. Chlorates are now made only by electrolysis of chlorides.

M. Gomberg and C. C. Buchler describe in the August number of the Journal of the American Chemical Society the preparation of benzyl ethers of carbohydrates. Glucose, sucrose, dextrin, starch, and cellulose are readily benzylated, and some of the products may be of technical importance from their colloidal and plastic characters.

Our Astronomical Column.

The Einstein Tower.—The *Observatory* for December contains an illustrated article on this tower, which has just been erected in the grounds of the Potsdam Astrophysical Observatory. It contains a vertical telescope of 50 cm. aperture and 14½ metres aperture, fed by a cœlostat. There are two spectrographs, one with a plane-grating of 12½ cm. aperture, the other with two large prisms giving a dispersion of two angstroms to 1 mm. The instrument will be chiefly employed to investigate the presence or absence of the Einstein shift, but it is available for general astrophysical work. It is in charge of Dr. E. Freundlich, under the general control of Prof. Einstein, who has now an appointment at Potsdam. Dr. Freundlich hopes to observe next year's eclipse from Christmas Island, with A. Kohlschütter and Dr. Voûte.

Changes in the Crab Nebula.—One of the very useful researches to which the great American telescopes have been applied is the study of changes in the nebulæ, by comparison of photographs taken at intervals of a few years. The changes have been in many cases unexpectedly large, and imply either relative nearness to the solar system or very high internal velocities.

Mr. Lampland had already reported some changes in the Crab Nebula deduced from seventeen photographs taken with the Lowell 40-inch reflector during a period of eight years. Mr. John C. Duncan gives in Proc. Nat. Acad. Sci., June, 1921, the results of a comparison of two photographs taken with the 60-inch reflector at Mount Wilson at an interval of eleven and a half years (1909 and 1921).

Twelve condensations were selected near the outer contour of the nebula, at tolerably equal intervals. Thirteen comparison stars were chosen, one near the centre of the nebula, the others fairly near the selected condensations. The results may be summed up thus: (1) the motions of the condensations are on the average quite three times as great as those of the stars; (2) while the star-motions are at random as regards direction, those of the condensations are systematically outward from the centre, being greatest at the ends of the long axis of the nebula, where they amount to 2″ in eleven and a half years, implying a linear speed of 25 km./sec. at an assumed distance of one hundred light-years. There is some (not very certain) evidence of a counter-clockwise rotation of the nebula. The mean motion of all the nebular condensations in eleven and a half years is +0·10″ in R.A., +0·435″ in Decl., referred to the mean of the stars.

The Astrographic Catalogue.—The publication of this great work was considerably in arrear even before the war, which, naturally, did not tend to improve the situation. It is satisfactory to note that volumes are now appearing in rapid succession.

Mr. H. B. Curlewis, director of Perth Observatory, West Australia, has catalogued the whole of zone −35°, the numbers of stars in each quadrant being 6879, 24,753, 22,139, 19,277. The paucity in the first quadrant is explained by its proximity to the South Galactic Pole. The magnitudes are given by letters, A denoting 8·5, B 9·0, and so on; the scale used is that of Chapman and Melotte, and differs from that used in earlier Perth volumes.

Mr. T. P. Bhaskaran has produced vol. 4 of the Hyderabad section, which catalogues the whole of zone −20°, the number of stars being 79,590. This volume completes the zone originally allotted to Hyderabad, about half the plates of which had been taken and measured before the death of Mr. Pocock in 1918. The work has been completed on the lines laid down by him. Standard co-ordinates of all stars contained in the Algiers Astr. Gesells. Catalogue are given at the end of the volume.

Señor Leon Herrero, director of San Fernando Observatory, has produced the first half of the catalogue for zone −3° (R.A. 0h. to 12h.). It contains 58,387 stars, and differs from most of the catalogues in containing X_0, Y_0 co-ordinates for all stars, in addition to the measured x, y.

Agriculture at the British Association.

AS was to be expected in an important agricultural district such as Edinburgh, the meetings of the Agricultural Section created a good deal of interest, and were well attended throughout the whole of the meeting.

One or two departures from the usual routine have to be noted. Dr. E. J. Russell, of Rothamsted, delivered a popular address to farmers on "Science and Crop Production" on the day before the formal work of the section began. There was a large attendance from the district, including many representative farmers, and the address was much appreciated. A report of Dr. Russell's address has already appeared in NATURE of September 22, p. 116. The second change was that the presidential address, instead of being read at the opening meeting, was circulated amongst the members. At the meeting on Monday, September 12, the president, Mr. C. S. Orwin, gave an abstract of his address, which was followed by a most useful discussion.

The number of papers offered to the committee was almost embarrassingly large; they were grouped, so far as possible, according to subject. On the opening day they dealt mostly with soil problems. Dr. Winifred E. Brenchley spoke on "The Effect of Long-continued Manuring of Grassland," and described the results of experiments which had been carried out at Rothamsted on permanent meadow-land for a period of sixty-six years—long enough to allow a true estimate to be made of the effect of the different fertilisers apart from the influences of season. The effects of complete manuring, one-sided manuring, no manure, and of lime were considered in detail. Dr. W. G. Smith discussed "Methods of Grassland Analyses," and described the results obtained from plots laid down with various grass mixtures in 1914. The plots were analysed annually, and figures were given showing the composition of the plots now as compared with what was laid down.

Dr. W. G. Smith and Dr. A. Lauder gave the results of a soil survey which had been carried out in the Lothians. More than 100 square miles have been surveyed and the vegetation recorded on 6-in. survey maps. Definite relations have been established between the types of vegetation and the productivity of the holdings, and simple methods of improving the grass were described. Dr. Lauder directed attention to the relation between the amount of organic matter and the lime requirement of the soil—a connection which had been noticed by other workers. Mr. M. M. Monie gave an account of a photographic survey of soils which he had carried out in the west of Scotland. His paper was illustrated with an excellent series of lantern-slides, and the method he proposes, while of limited use by itself, should have a useful place in soil-survey work.

Prof. Hendrick dealt with "The Absorption and Retention of Manurial Substances by Granitic Soils." These soils are free from carbonate of lime, have a slightly acid reaction, and a high lime requirement. Notwithstanding these conditions, it was found that, even in very heavy dressings, ammonia was almost completely fixed and an equivalent quantity of nitrates recovered in the drainage. The phosphate was also completely retained. The potash was less firmly held, and in the later periods of the experiment the retention was very slight.

Mr. H. J. Page and Mr. H. G. Thornton contributed an important paper on "The Rapid Fluctuations in Bacterial Numbers and Nitrate Content of Field Soil and their Interrelation."

On Friday the papers dealt largely with dairying problems. Prof. R. A. Berry dealt with the important commercial question of "The Production and Utilisation of Whey." He showed that on a moderate estimate the amount of whey produced annually is worth 337,000*l*. He emphasised the great loss involved under the present methods of disposal, where large quantities are allowed to run to waste, and discussed the possibility of new methods of utilisation. In addition to pig-feeding, the possibility of preparing milk-sugar and whey powders was considered.

Prof. R. H. Leitch described the recent work he had carried out with starters in cheese-making, as well as experiments in the manufacture of rennet, methods of standardising rennet extracts, and some new developments in butter-making. Dr. W. Taylor and Mr. A. D. Husband contributed a note on "The Varying Rates of Secretion of Milk on its Percentage Composition." They come to the conclusion that the interrelationship of volume and composition may be summarised thus:—The percentages of protein, fat, and ash vary inversely, and the percentage of lactose varies directly as the daily volume of milk secreted. Two papers were contributed by Dr. Tocher, one dealing with "The Statistical Analyses of Scottish Milk Records," and another dealing with "The Methods of Determining the Significant Differences of Yield of Milk."

Prof. Hendrick described "A New Scheme for the Determination of Unexhausted Manurial Values," and dealt in particular with the question of cumulative fertility. Dr. Tocher gave the results of experiments on "The Citric Solubility of Manurial Phosphates," and concludes that citric solubility is a worthless test from the agricultural point of view. The only practical tests are:—(1) The total phosphatic content, (2) the degree of fineness of grinding, and (3) freedom from substances of an injurious character to plants.

Mr. J. Alan Murray described some recent experimental work which he had carried out on "The Composition of Ensilage." Mr. Murray dealt with the loss involved in the making of ensilage, and considered that it was a fallacy that farmers can save money by dispensing with root crops and substituting ensilage in the rations of farm animals. He considered that it was not possible to reduce the allowance of concentrated food by substituting ensilage for roots. In the discussion which followed some exception was taken to Mr. Murray's estimates as to the cost of producing ensilage.

The meeting on Monday was devoted to economic questions, and began with the discussion on the president's address, to which reference has already been made. Lord Bledisloe followed with a paper on "Wheat as the Basis of Britain's Food-Supply in Time of War." He pointed out the advantages of potatoes, supplemented by pig-meat, over wheat. Great Britain is self-contained in its potato requirements and an exporter, while under normal conditions she imports four-fifths of her wheat requirements from abroad. The normal production of wheat is preponderantly in the eastern counties of Great Britain (ten counties out of eighty-six provide more than half the total output), while potatoes are grown in every part of the kingdom. Many farmers are wholly unfamiliar with wheat production, and have neither the implements nor the buildings necessary for its production and storage, but every farmer, gardener, and allotment-holder knows how to grow potatoes. Then again, the wheat crop may be wholly lost for human requirements through bad weather or incendiarism. Potatoes, though subject to disease (which can be minimised by spraying), are less vulnerable, as the edible tuber is beneath the ground. Potatoes provide an

immense quantity of starchy food, far exceeding wheat in output per acre, and the crop can be obtained in shorter time and harvested at different periods of spring, summer, and autumn. Potatoes are, however, relatively deficient in fat and protein, but these can be supplied, by way of supplement, by pig-meat. The production of pigs in war-time should, therefore, be encouraged, and not discouraged as during the late war; their capacity for rapid reproduction, large families, high percentage of fat-yield, and great variety of food products render them invaluable meat-providers in a national emergency. Grazing varieties deserve special encouragement. Another reason for the encouragement of potato-growing lies in the large areas of permanent and temporary pasture, valuable storehouses of accumulated fertility, which can be utilised in time of war when fertilisers are bound to be scarce; no crop thrives better in newly-turned pasture than potatoes. Potato-flour is also useful, for it can be converted into wholesome and palatable bread, scones, and cakes, while surplus or unsuitable potatoes can be utilised both as stock food and as the source of motor spirit, commercial starch, etc. The home production of breadstuffs in the form of potatoes will reduce to a minimum the costs and risks of marine transport, and their production in every part of the kingdom for local needs will largely reduce the strain on internal transport.

In the discussion which followed some doubt was expressed as to whether it would be wise to rely so exclusively on one crop as a source of food, especially in view of the danger of the total failure of the crop by disease.

Sir Henry Rew communicated a paper on "Agricultural Statistics: Their Collection and Use" (Journal of the Ministry of Agriculture, vol. 28, p. 636, 1921); Mr. A. W. Ashby dealt with "Standards of Production in Agriculture," and Mr. Pryse Howell with "Economic Surveys of Agriculture in Wales."

On Tuesday the papers contributed dealt mostly with nutrition problems. Dr. W. E. Elliot and Mr. Arthur Crichton contributed a paper describing a series of feeding and metabolic experiments which had been conducted on pigs with the object of determining the cause of a disease variously known as "rheumatism," "cramp," or "rickets." They conclude from the results of their experiments that the condition is produced in animals deprived of access to earth or other mixtures of minerals, and fed only on grains and certain other concentrates commonly used in pig-feeding. The inorganic constituents in these feeding-stuffs do not correspond with the requirements of the growing pig, for there is a marked deficiency of calcium and an excess of acid radicles. If the mineral matter of a ration composed of these feeding-stuffs be adjusted to the requirements of the animal by a mixture of salts compounded to correct the deficiences the disease does not occur. The addition of fat soluble A or of water soluble C to a ration that produces the condition does not prevent the onset of the symptoms. Mr. John Golding exhibited photographs of a litter of pigs from a sow which was fed on a diet deficient in vitamins; they all suffered from serious malformation of the hindquarters. In the discussion which followed exception was taken to the conclusions arrived at by Dr. Elliot and Mr. Crichton, and it was considered by some speakers that it had not been proved that the disease in question was solely due to a deficiency in mineral matter in the ration.

Dr. J. B. Orr then gave an account of "The Application of an Indirect Method of Calorimetry to the Ruminant," and described the apparatus as adapted for experiments with goats.

Major C. C. Hirst gave a paper on "The Genetics of Egg-production in Poultry." Major Hirst described the results of five years' experimental breeding on Mendelian lines, and showed that the first year's egg-production of a hen depends on the combined action of at least seven main genetic factors. The economic significance of the results was discussed in detail, and the effects of the old methods of grading by winter and annual records were pointed out. The new system of grading production has a double value to the practical breeder, because the descriptive somatic gradings, being based on the genetic factors concerned, give a line also to the breeding value of the bird, for the extreme grades tend to breed true. The adoption of this grading system for laying competitions would lead to rapid progress in poultry-breeding, and be of educational value to poultry-keepers in general, for the winning birds would breed winners with more frequency than they do now.

Miss Dorothy J. Jackson described an investigation which she had carried out in the genus Sitones with the object of investigating which species were injurious to leguminous crops in Britain; the life-history of these species has also been determined. No satisfactory method of control is at present known. In the case of the species which breed on clover control would be extremely difficult on account of their prolonged period of egg-laying, but this difficulty would not apply to the species which breed upon peas and beans. Laboratory experiments on infection with the various fungus spores of *Botrytis bassiana* (*Balsamo*), Montagne, have proved successful, death invariably occurring in from nine to thirteenth days.

In a paper by Miss M. S. G. Breeze "The Degeneration in Anthers of Potato" was discussed. Two definite types of degeneration have been observed:—(1) Where the pollen-grains are formed, but degenerate at various stages of development, and (2) in which the pollen mother-cells are apparently normal, but no reduction division takes place. The question of the inheritance of degenerate condition of anthers was also discussed.

In addition to the formal meetings a visit was paid to the Station for Research in Animal Breeding, where a demonstration on the wools of primitive breeds of sheep was given by Dr. F. A. E. Crew. Dr. R. Stewart MacDougall had an interesting exhibit of insects injurious to stock, while in the library of the Agricultural Department there was an exhibition of early works dealing with agriculture and kindred subjects.

On the Friday afternoon the new Plant-Breeding Station at East Craigs, Corstorphine, was inspected. The party was received by Dr. C. M. Douglas, of Auchlochan, chairman of the committee, and Mr. Drummond described the work of the station. Afterwards the farm of Mr. John Cowper at Gogar Mains was visited.

On the Saturday a whole-day excursion took place to typical farms in East Lothian. The concluding visits were to the well-known farms of East Barns and Barnehill, where the party was received by Sir Harry and Lady Hope.

If a word of criticism may be indulged in, attention might be directed to the fact that few of the readers of papers seriously tried to confine themselves to the time allotted to them in the programme or made a real endeavour to prepare an abstract of their work suitable for presentation to the meeting. In this way the amount of time available for discussion was much too short. The number of papers accepted was probably rather large, but much time would have been saved had some of the readers appreciated the fact that the time at their disposal was necessarily very limited.

A. LAUDER.

The Megalithic Monuments of Malta.

AT a meeting of the Royal Anthropological Institute held on November 15 last Miss M. A. Murray gave an account of her recent excavations in Malta. The excavations were carried out with the consent and kind help of Prof. Zammit. Three sites were explored, all three being in the south-east of the island. The first excavation was of a mound called Santa Sfia, near the village of Hal Far; this proved to be a megalithic site re-used later, and yielded no result. The second excavation was at Santa Maria tal Bakkari, about half a mile away. Here the remains of a double edifice, locally supposed to be two churches, were found. But various indications, amongst others a torba floor, suggest that the building was pre-Christian, and the form and position of many of the stones show that it was originally a megalithic structure. The supposed dedication of the double building to Santa Maria and Santa Katerina may indicate that the shrine was dedicated to two goddesses, and may therefore throw some light on the early deities of Malta. The name of St. Mary is too universal to be any guide, but as St. Katherine has taken the place of a goddess of beacons and lighthouses, we may have here a sanctuary of that divinity. The position of the shrine lends itself to this conjecture, as it stands on high ground in a direct line with a tiny creek, now unused, but sufficiently large for the small fishing-boats of Neolithic times. The name Tal Bakkari is probably connected with the Arabic Fagr, "dawn, daybreak"; the name "St. Mary (or the goddess) of the daybreak" would be appropriate for a shrine built on a hill, from which the open sea due eastward across the Bay of Marsa Scirocco is clearly visible. The first rays of the rising sun strike directly on the shrine.

The third excavation was at Borg en Nadur, close to St. George's Bay. A group of megaliths have always been a well-known feature of the site; this group consists of two dolmenic structures and a building which now appears to be a semi-circular apse, like the apses at Tarxien and the other Maltese temples. In the short time that could be devoted to this excavation it was possible only to prove that the building extended over a wide area, and may possibly be a double temple like those already known. Behind the uncovered apse and on a level with its highest stones is a field, terraced up to its present height in the usual way by a wall of stones. The axis of the "temple" runs directly into this field, and it is very probable that the whole building remains intact hidden under the soil, as was the case at Tarxien. Excavations in the field in which the uncovered apse stands showed a megalithic building extending more than a hundred feet northward from the apse, and a broken bætyl was found *in situ*. Time did not permit of more than a cursory examination of this portion of the site, and it is still uncertain how far or in what way this building is connected with the apse. South-eastward from the apse is another dolmenic structure built into the wall of the field, and adjoining it in the field behind is an apse filled in and covered with stones, but retaining the characteristic semi-circular form. Excavations on the site will be continued next year.

In the course of the discussion which followed the paper Sir Arthur Evans said that, taking the megalithic monuments in Malta as a whole, it was clear that they belonged to a western Mediterranean province which included Sardinia, the Balearics, and possibly the African side. In the Bronze age the evidence was clear; the implements fitted on to the Spanish group. In Spain are found small segmented beads of faience which were a stage in similar forms found in Scotland and parts of England, and began in Egypt with the XVIIIth Dynasty, and appeared in Crete at about the same time. Possibly they were diffused by the Cretans. Although the segmented beads had not been found in Malta, an imitation, associated with them in Spain, had been found there, and it was probable that the segmented beads would also be found. The Neolithic ornament showed a regular progression, starting from Hagia Kim, but it appeared at so advanced a stage that it could not have originated there, and was, possibly, to be derived from Egypt. A vase from Kamares showed strong affinities with a vase from the Neolithic chambers of Malta. The deduction was that the later stage of this culture in Malta came down to about 1600 B.C.

Mr. Peake referred to the rapid development which had taken place in our knowledge of the prehistory of Malta. In 1913 nothing was known of the Bronze age, but the knowledge of an independent type of pottery had now been developed. The evidence pointed to 1800 B.C. as a possible date for Hal Tarxien. The culture was identical with that found all over the megalithic area. The pottery, for instance, was common to Taranto, Spain, Brittany, Guernsey, Arran, Scandinavia, and also Algiers. The only locality outside the megalithic area in which it occurred was Sicily, where, however, a double spiral stone occurred, similar to one from Hal Tarxien, showing that it belonged to the same order. In connection with his suggestion that this culture came from the East, it was interesting to note that Prof. Zammit had also suggested a connection between Malta and the Persian Gulf.

Graft-Hybrids.

AMONG the departures in procedure which marked the Edinburgh meeting of the British Association was the prominence given to a botanic lecture which aimed at a scientific, but non-academic, account by Prof. Weiss of "Graft-Hybrids." Grafting had been a horticultural practice from very ancient times, and was said to date from that of the Phœnicians, and was certainly practised by the Romans, who believed that the stock exercised considerable influence over the scion.

The question of the production of hybrids by grafting first came to the notice of scientific observers in connection with the *Bizzaria orange*, raised in Florence in 1664, and described in the second volume of the Philosophical Transactions of the Royal Society of London. In this case an orange grafted on a lemon stock bore a large variety of fruits, some resembling oranges, some lemons, while others were intermediate in shape and colour. The most curious combination appeared to consist of an orange shell with lemon pulp. This latter feature was significant in relation to the "graft-hybrids" afterwards obtained, probably the best known and most frequently discussed of which is *Cytisus Adami*, obtained in Paris in 1825 by grafting a small purple-flowered *Cytisus purpureus* on an ordinary yellow laburnum. The graft did not succeed, but from a small bud arising close to the place of insertion a branch was produced inter-

mediate in character between scion and stock. The graft-hybrid is generally sterile, and therefore is usually kept going by grafting. On the rare occasions when seed is set it produces normal yellow laburnum.

In the account given by McFarlane in the Transactions of the Royal Society of Edinburgh for 1892 the suggestion was made that the distribution of characters is such that the graft-hybrid consists apparently of a core of laburnum wrapped in a skin of Cytisus. This supposition has been confirmed in the more recent production of graft-hybrids by grafting common nightshade on the stem of a tomato and *vice versa*. In all cases the stock would appear to furnish the core and the scion the epidermal tissues of the "hybrid."

This simple explanation, however, does not appear to cover fully the graft-hybrids between medlar and hawthorn obtained by Prof. Daniel, in one case of which, at any rate, tissues were present which differed from those of either parent.

In general, therefore, graft-hybrids represent shoots produced adventitiously near the point of grafting and containing representation of the tissues of both plants, in many cases, *e.g. Cytisus Adami*, so arranged that the external tissues resembled those of the scion and the internal those of the stock. There were, however, instances—*e.g.* quince and pear—in which an intimate mixture of the characters of stock and scion appeared in the graft-hybrid which *may* have been accompanied by vegetative union of the cells, but no clear case of this cytological process had yet been established.

The whole phenomenon of graft-hybrids requires further investigation, particularly in relation to cases in which the "hybrid" is said to occur on the scion far removed from the point of grafting, which may turn out to be instances of bud variation, possibly with reversion.

Fauna of African Lakes.

DR. W. A. CUNNINGTON, leader of the third Tanganyika Expedition (1904–5), has contributed to the Proceedings of the Zoological Society of London (December, 1920), a comparative study of the fauna of the African lakes—Tanganyika, Victoria Nyanza, Nyasa, Albert Nyanza, Edward Nyanza, and Kivu, with special reference to the first-named. The results of recent investigation, admirably summarised in this memoir, lend no support to the view put forward in 1898 by Mr. J. E. S. Moore, leader of the first and second expeditions, that Tanganyika represents an old Jurassic sea, and that its fauna is of relict nature. Of the six lakes, Tanganyika has by far the most remarkable fauna—of its 402 species 293 are endemic, and 57 of its 168 genera are peculiar to its waters; of the 146 species of fishes 121 are endemic, and a notable feature is the high degree of specialisation of the Cichlidæ, the lake presenting the richest known assemblage of this family. There is a large molluscan fauna, and of the species of gastropods more than two-thirds—the halolimnic forms (Moore)—exhibit a marine-like appearance, and these are, without exception, endemic. Noteworthy is the absence of Cladocera, and the relative scarcity of rotifers, which may be correlated with the salinity of the water, and especially with the excess of magnesium salts. Dr. Cunnington points out that geological investigation indicates that the extensive beds of sandstone and conglomerate which occur in the lake regions were probably formed under fresh-water and terrestrial conditions, that the trough in which Tanganyika lies was apparently not formed until middle tertiary times, and that the lake had no outlet until recent geological times. Experts have not accepted Moore's comparison of shells from the lake with marine fossil shells of Jurassic age, or his views as to the primitive nature of the halolimnic gastropods. The endemic species in the fauna of Tanganyika are now held to be specialised rather than primitive. The conclusion reached is that Tanganyika owes its remarkable fauna to a long period of isolation, sufficiently extensive for the inhabitants of the lake to assume the characters of species and even genera distinct from those of the neighbouring parts of the continent.

University and Educational Intelligence.

IN connection with the Conference of Educational Associations which is being held at University College, Gower Street, W.C.1, the annual general meeting of the Education Guild of Great Britain and Ireland took place on December 30. The president of the guild, Sir Wilmot Herringham, delivered the presidential address, taking university education as his topic. He commented on the lack of interest in university education shown by the majority of people, and emphasised the value of the inclusion of natural sciences in a general education as a training in inductive reasoning. There is also material gain by the training of a number of skilled practitioners in chemistry, physics, engineering, medicine, etc., but the most important function of the university is discovery. Taking examples from medical science only, gas gangrene, surgical shock, and the effects of poison gas were mentioned as specific problems arising during the war in which investigations were undertaken with success in university laboratories. Another interesting fact mentioned was that between 1838 and 1851 out of every million people born in Great Britain 500,000 died before the age of forty-five years; in 1881 that age had risen to forty-eight; and by 1891 it was fifty-two years—an increase in average life due, at any rate in part, to research and discovery accomplished by men of science working in the laboratories of our universities.

ACCORDING to the December issue of the *School Science Review*, the representatives of the Science Masters' Association met the Joint Standing Committee of the Headmasters' Conference and Association of Preparatory Schools in June last and made certain suggestions for the teaching of science in preparatory schools. As a result it was recommended that (1) in the Common Entrance Examination the scope of the geography paper be widened, that some of the questions in the mathematical paper should test a boy's knowledge of practical mathematics, and that in the composition paper candidates should have an opportunity of showing a knowledge of natural science; (2) candidates for scholarships should be given an opportunity of answering questions on natural science in a *viva voce* examination as well as in the general paper; and (3) at least one, and if possible two, periods a week should be devoted in preparatory schools to science. The council of the Association of Preparatory Schools was at first unwilling to adopt any of these proposals, but after they had been approved by the Headmasters' Conference the council of the Association of Preparatory Schools agreed to them by 12 votes to 3. When this decision is carried into effect boys in preparatory schools will have an opportunity of gaining some knowledge of science at an age when all natural phenomena are of absorbing interest to them—a privilege boys in secondary schools have enjoyed for some time.

Calendar of Industrial Pioneers.

January 1, 1890. Horatio Allen died.—A pioneer among American locomotive engineers, Allen visited the Stockton and Darlington Railway in 1828, and afterwards conveyed to the United States the locomotive "The Stourbridge Lion." In 1871–73 he served as president of the American Society of Civil Engineers.

January 2, 1875. Eber Brock Ward died.—In 1864 Ward erected an experimental steel plant at Wyandotte, Michigan, where the first Bessemer steel made in the United States was produced. He was among the earliest to erect a works laboratory and to employ a works chemist. He also did important work in connection with water and rail transport.

January 3, 1795. Josiah Wedgwood died.—The friend of Watt, Erasmus Darwin, and Priestley, and a fellow of the Royal Society, Wedgwood by his experiments added several new species of pottery ware to English manufacture and turned the current of importation of the finer earthenwares into that of exportation. "He was the most successful and original potter the world has ever seen."

January 5, 1887. Sir Francis Bolton died.—The inventor of a system of signalling for the Army and Navy, Bolton was widely known for his electrical work, and he took a prominent part in founding the Society of Telegraph Engineers and Electricians, now the Institution of Electrical Engineers.

January 6, 1911. Sir John Aird died.—For sixty years Aird was engaged on important engineering schemes, his crowning work being the famous Assuan dam on the Nile built for the Egyptian Government in 1898–1902. The dam is 2200 yards long, it has 180 sluice-gates, and contains more than 1,000,000 tons of masonry.

January 6, 1886. Alhémar Jean Claude Barré de Saint Venant died.—Engaged for many years on practical work as an *ingénieur des ponts et chaussées*, Saint Venant was an eminent elastician, contributing much to the study of the strength of structures.

January 8, 1861. Samuel Clegg died.—A pupil of Dalton, Clegg while an apprentice at Birmingham witnessed Murdoch's experiments on gas lighting and himself became one of the pioneers of the gas industry.

January 8, 1825. Eli Whitney died.—Holding a pre-eminent place among the early inventors of America, Whitney, though originally a blacksmith, graduated at Yale, and while a private tutor in 1793 produced his cotton gin. This enabled one man to clean a thousand pounds of cotton a day instead of five or six pounds. In twelve years the export of cotton rose from 189,000 lb. to 4,000,000 lb. per annum.

January 9, 1843. William Hedley died.—With Trevithick, Stephenson, Blenkinsop, and Hackworth, Hedley was one of the pioneers of the locomotive. In 1813 at Wylam Colliery, near Newcastle, he built the "Puffing Billy," the first practical and efficient locomotive ever constructed. This engine is now in the Science Museum at South Kensington.

January 9, 1862. Samuel Colt died.—In 1835, at the age of twenty, Colt patented his repeating pistol or revolver, for the manufacture of which he built a factory where automatic and semi-automatic machinery was used.

January 11, 1877. Alfred Smee died.—Surgeon to the Bank of England, Smee was best known for his work on electricity. The Smee battery was devised by him, and he did pioneering work in electric metallurgy, including the art of electrotyping. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, December 19, 1921.—M. Georges Lemoine in the chair.—The president announced the death of M. Henry Parenty, correspondant for the section of mechanics.—E. **Borel**: The theory of games of chance and integral equations with symmetrical nucleus.—P. **Termier** and L. **Joleaud**: Summary of our knowledge of the Suzette layer (exact age, constitution, and extent): the question of its origin. This layer came from the Alps in the Aquitanian period, and is exclusively formed of Triassic elements.—C. **Richet**: The psychological unity of time.—G. **Gouy**: The surface tension of electrified electrolytes. In a recent communication M. Félix Michaud has proved that the surface tension of an electrolyte is not changed by the electrification of the surface, and hence raises an objection to the ionic hypothesis, since the ions, by accumulating at the electrified surface, should modify the capillary forces. The author states that it is not the ionic theory that is at fault, but the view that the charge is constituted by the ions accumulated at the surface. The latter hypothesis is inadmissible, since a small charge does not diminish the osmotic pressure in the interior of the electrolyte nor the total number of ions per unit of volume.—G. **Friedel** and L. **Royer**: Mixtures of anisotropic liquids and the identity of the stratified liquids of Grandjean with liquids of the azoxyphenetol type.—R. **Lagrange**: The absolute differential calculus.—J. **Wolff**: The series $\sum \frac{A_k}{z-a_k}$.—A. **Denjoy**: Quasi-analytical functions with real variable.—E. **Delassus**: Closed articulated chains.—H. **Abraham** and R. **Planiol**: An astronomical chronograph of precision. An auxiliary electrical clock, controlled by an astronomical clock, beats tenths and twentieths of a second, and these are marked on a smoked strip by a recording galvanometer; the same instrument records the observed times on the same strip, and an accuracy of 0·01 sec. (or greater if required) is readily attained by a direct reading without a micrometer.—J. P. **Lagrula**: The principle and scheme of a recording chronograph with geometrical synchronisation.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the third quarter of 1921. Ninety days' observations are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—E. **Esclangon**: The relativity of time.—J. **Le Roux**: Interference and reflection in a mobile system.—J. **Chappuis** and M. **Hubert-Desprez**: Electrolysis by stray currents. Two metal plates forming the electrodes were placed in sawdust or earth moistened with an electrolyte contained in a wooden box. The course of the corrosion was followed continuously by X-ray photographs.—M. **Taffin**: The measurement of double refraction in tempered glass.—M. **Siegbahn**: New measurements of precision in the X-ray spectrum. A description of an improved instrument of a type described in 1918, capable of measuring a wave-length with an accuracy of 0·002 per cent.—A. **Sellerio**: Analogies and differences between the total galvanomagnetic effect and its correlative thermomagnetic effect.—J. **Duclaux**: The mechanism of continuous-light radiation.—B. **Bogitch**: The expansions of some refractory materials at high temperatures. Refractory bricks of silica, bauxite, clay, chromite, and magnesia and their expansions were studied up to 1500° C. Bauxite bricks had the lowest coefficient of expansion. Silica gave an irregular curve and lost

its strength at about 600° C. The highest expansions were shown by magnesia and chromite bricks, and hence these are suitable only for furnaces in continuous work.—A. **Charriou**: The lime carried down by ferric hydroxide precipitates. To reduce the amount of lime adsorbed by precipitated ferric hydroxide to a minimum the calcium chloride solution should be very dilute and the ammonia added only just sufficient to precipitate the iron.—M. **Grandmougin**: The halogen derivatives of indigo.—J. B. **Senderens** and J. **Aboulenc**: The catalytic hydrogenation of the polyphenols in the wet way. Hydroquinone, resorcinol, pyrocatechol, pyrogallol, and phloroglucinol can be reduced in the presence of nickel by hydrogen under pressure (30 to 50 atmospheres) at temperatures between 115° C. and 145° C. At higher temperatures secondary reactions take place; thus resorcinol at 120° C. gives resorcite (1 : 3-*cyclo*hexanediol), but at 180° C. some *cyclo*hexanol is produced.—M. **Lespieau**: Derivatives of erythritol-acetylene,

$$CH_2(OH)\cdot CH(OH)\cdot C\equiv C\cdot CH(OH)\cdot CH_2(OH).$$

—R. **Fosse**: The synthesis of a nitrogenous principle of plants, hydrocyanic acid, by the oxidation of ammonia and carbohydrates, glycerol, or formaldehyde. Potassium (or calcium) permanganate, in presence of silver nitrate, with ammonia and various organic bodies, gives cyanides as one of the oxidation products. —C. **Jacob** and M. **Removille**: A fall of meteorites in Cochin China.—P. **Viennot**: The southern edge of the north Pyrenean Flysch, between the valleys of Aspe and Saison.—J. **Yung**: The Hercynian tectonic of the Vosges.—P. **Corbin**: New observations on the eastern border of the mountains of Lans.—Mlle. J. **Pfender**: The presence of pebbles not of local origin at Alon (Var).—E. **de Martonne**: Erosion platforms of the metalliferous mountains of Banat.—Mlle. Yvonne Boisse **de Black**: Researches on the Mindelian alluvium in the high valley of Cère and on the plateau of Lacapelle-Barrez (Cantal).—P. **Loisel** and R. **Castelnau**: The radio-activity of the waters from Mont-Dore. Determinations of the radio-activity of the water from twelve hot springs are given; the gases from eight springs have also been examined. The gases contain a higher proportion of radium emanation than the waters, and this proportion varies with the spring and with the date of collection.—A. **Boutaric**: The nocturnal radiation at Mont Blanc.—G. **Arnaud**: The affinities of the Erysiphæ and the Paradiopsidæ.—L. **Blaringhem**: Heredity and physiological characters in the hybrids of barley.—G. **André**: The transformations undergone by oranges on keeping. The ripening of oranges by keeping is due to a reduction of acidity, the loss of sugars being relatively small. These changes cannot be wholly due to oxidation, since they are produced in a vacuum. Diastatic action is suggested as possible.—P. **Dangeard**: The evolution of the aleurone grains in castor-oil seed during germination.—M. **Bridel** and Mlle. Marie **Braecke**: The presence of saccharose and aucubine in the seeds of *Melampyrum arvense*. Full details are given of the method of extracting saccharose and the glucoside aucubine from the seeds. Rhinanthine, extracted by Ludwig from the seeds of *Rhinanthus Crista-Galli*, was also stated by Ludwig and Müller to be present in the seeds of *Melampyrum arvense*. The identity of rhinanthine with aucubine has not yet been proved.—H. **Hérissey**: The biochemical synthesis of α-methyl-*d*-mannoside. By the action of the ferment present in germinated lucerne seeds upon *d*-mannose in dilute methyl alcohol solution, α-methyl-*d*-mannoside is formed. Details of method of isolation and proofs of identity are given. —A. **Demolon**: The sulphur-oxidising power of soils.

—L. **Mercier**: The larva of *Limnophora aestuum*, a marine Diptera.—A. **Michel**: The interpretation of the profound histological differentiation of the dorsal elytra and cirrus of the Aphroditian Annelids.—J. L. **Lichtenstein**: The determination of egg deposition in *Habrocytus cionicida*.—L. **Roule**: The periodic changes of habitat of the common tunny fish (*Orcynus thynnus*) and their connection with the changes of medium. The migrations of the tunny fish are determined by the temperature and salinity.—L. **Léger** and E. **Hesse**: Microsporidia with spherical spores.—L. **Ravaz** and G. **Vergé**: The germination of the spores of vine mildew. Lime solutions are carbonated too rapidly on exposure to air to exert any toxic action on the mildew spores. Copper-lime mixtures resist the action of rain and dew and preserve their toxic power.—R. **Legroux** and J. **Jimenez**: The factor of growth in cultures of *Leishmania Donovani*.—G. **Bourguignon** and A. **Radovici**: Chronaxy of the sensitive rachidian nerves of the upper limb in man.—E. **Nicolas** and P. **Rinjard**: The vaccination of cattle against bovine plague.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 11 (November, 1920).—A. **Weinstein**: Homologous genes and linear linkage in *Drosophila virilis*. A long and detailed study with numerous bibliographic references, not lending itself to recapitulation.—F. C. **Hoyt**: The intensities of X-rays of the L-series, III. Critical potentials of the platinum and tungsten lines. A continuation of an earlier work to the classification of some lines that were doubtful.—E. B. **Stouffer**: Semi-variants of a general system of linear homogeneous differential equations.—A. G. **Webster**: Some new methods in interior ballistics. A *résumé* of extended experiments on the principal problem of interior ballistics, namely, to determine the position and velocity of the shot, and the mean temperature and pressure of the gases in the gun. Graphical and analytical methods are used.—C. B. **Bridges**: The mutant crossveinless in *Drosophila melanogaster*. —J. A. **Detlefsen**: Is crossing over a function of distance? The author differs from the conclusion of many students of genetics, and believes that linkage is not a function of distance, that the distance between the two genes may remain fairly constant, and that the crossing over depends upon hereditary factors.—E. E. **Babcock** and J. L. **Collins**: Interspecific hybrids in Crepis. The behaviour of the seven-chromosome Crepis hybrid leads to the belief that there is not such a direct relationship between the two parent species as has been suggested.—C. G. **Abbot**: New observations on the variability of the sun. A discussion of an extended set of observations from July, 1919, to March, 1920, revealing a wide fluctuation in the sun's radiation.—L. P. **Eisenhart**: The permanent gravitational field in the Einstein theory.—G. A. **Linhart**: A simplified method for the statistical interpretation of experimental data.—C. B. **Lipman** and G. A. **Linhart**: A critical study of fertiliser experiments. From a statistical study of fertiliser experiments the authors conclude that no fertiliser experiment as ordinarily conducted is possessed of sufficient practical value to justify the large amount of money, time, and energy involved.

No. 12 (December, 1920).—H. **Shapley**: Preliminary report on pterergates in *Pogomyrmex Californicus*.—J. F. **McClendon**: Hydrogen-ion concentration of the contents of the small intestine. Criticism of the general erroneous impression that the intestinal contents are alkaline.—F. P. **Underhill** and M. **Ringer**: Blood concentration changes in influenza. Both

physiologically and pathologically there is a marked resemblance between influenza and war-gas poisoning, with a marked increase in the concentration of the blood.—E. L. **Nichols** and D. T. **Wilbur**: Luminescence at high temperatures. Announcing the discovery of luminescence at temperatures which are, roughly speaking, above the beginnings of a visible red heat.—S. R. **Detwiler**: Functional regulations in animals with composite spinal cords. The evidence indicates that the factor which is involved in the over-production of motor cells is the stimulus afforded by the connection with the central neurones.—A. S. **King**: Experiments with the tube resistance furnace on the effect of potential difference. The conclusion is that the potential difference acting on the tube is not effective in modifying the spectrum in certain temperature ranges.—J. H. **McDonald**: An application of the porism of four tangents of a twisted cubic.—H. A. **Cheplin** and L. F. **Rettger**: Studies on the transformation of the intestinal flora, with special reference to the implantation of *Bacillus acidophilus*, II. Feeding experiments on man. Attempts to implant *Bacillus bulgaricus* failed, as in the feeding experiments on rats. It appears that *Bacillus acidophilus* milk possesses several advantages over ordinary sour and *Bacillus bulgaricus* milk.—Kilauea Volcano Observatory: A report by the committee of the National Academy of Sciences at the request of the Secretary of Agriculture with reference to desirability of the control of the observatory being assumed by the Weather Bureau.

Official Publications Received.

Legislative Document No. 39: State of New York. Thirty-second Annual Report of the New York State College of Agriculture at Cornell University and of the Agricultural Experiment Station established under the Direction of Cornell University, Ithaca, New York, 1919. Vol. 1. Pp. civ+1074+30+8+57 plates. Thirty-third Annual Report, 1920. Transmitted to the Legislature, January 15, 1921. Pp. 79+4. (Ithaca: Cornell University.)

Cornell University: Agricultural Experiment Station. Memoir 34: An Economic Study of Farm Layout. By W. T. Myers. Pp. 383-564. Memoir 35: Some Effects of Potassium Salts on Soils. By R. S. Smith. Pp. 565-606. Memoir 36: Resistance of the Roots of some Fruit Species to Low Temperature. By D. B. Carrick. Pp. 607-662. Memoir 37: A Modified Babcock Method for Determining Fat in Butter. By N. W. Hepburn. Pp. 663-690. (Ithaca: Cornell University.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 113, Special Publication No. 60: A Study of Map Projections in General. By O. S. Adams. 5 cents. Serial No. 121, Special Publication No. 62: Triangulation in Rhode Island. By Earl Church. 30 cents. Serial No. 143, Special Publication No. 67: Latitude Developments Connected with Geodesy and Cartography. By O. S. Adams. 20 cents. Serial No. 146, Special Publication No. 68: Elements of Map Projection, with Applications to Map and Chart Construction. By C. H. Deetz and O. S. Adams. 50 cents. Serial No. 150, Special Publication No. 69: Modern Methods for Measuring the Intensity of Gravity. By C. H. Swick. Pp. 96. 15 cents, Serial No. 155: Results of Observations made at the U.S. Coast and Geodetic Survey Magnetic Observatory, near Tucson, Arizona. By D. L. Hazard. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water Supply Paper 449: Ground Water in the Meriden Area, Connecticut. By G. A. Waring. 466: Ground Water in the Southington-Granley Area, Connecticut. 468: Records of Water Levels in Wells in Southern Carolina. By F. C. Ebert. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 719: Preliminary Report on Petroleum in Alaska. By G. C. Martin. 50 cents. Bulletin 721: Geology and Petroleum Resources of North-Western Kern County, California. By W. A. English. 10 cents. Bulletin 715-M: Permiam Salt Deposits of the South-Central United States. By N. H. Darton. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 72, No. 8: A Review of the Interrelationships of the Cetacea. By H. Winge. Translated by G. S. Miller, Jr. (Publication 2650.) Pp. ii+97. Vol. 72, No. 11: The Echinoderms as Aberrant Arthropods. By A. H. Clark. (Publication 2653.) Pp. ii+20. (Washington: Smithsonian Institution.)

Canada. Department of Mines: Mines Branch. The Preparation, Transportation, and Combustion of Powdered Coal. By J. Blizard. Pp. 131+3 plates. (Ottawa: Department of Public Printing and Stationery.)

Tide Tables for the Eastern Coasts of Canada for the Year 1922, including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits, and Information on Currents. Issued by the Tidal Current Survey in the Department of the Naval Service of the Dominion of Canada. (Twenty-sixth Year of Issue.) Pp. 68. (Ottawa: Department of Public Printing and Stationery.)

Experiment Station of the Hawaiian Sugar Planters' Association. The Improvement of Plants through Bud Selection. By A. D. Shamel. Pp. iv+28+41 plates. (Honolulu.)

Madras Agricultural Department. Year Book, 1920-21. Pp. vi+123. (Madras: Director of Agriculture.) 10 annas.

Office scientifique et technique des Pêches Maritimes. Notes et Mémoires No. 8: Rapport sur la campagne de Pêche de l'Orvet dans les Eaux tunisiennes. Par Prof. G. Pruvot. Pp. 12+1 map. 3 francs. Notes et Mémoires No. 9: Recherches sur le Régime des Eaux Atlantiques, au large des Côtes de France et sur la Biologie du Thon Blanc ou Germon (Observations faites pendant la seconde croisière de la Tanche, Août et Septembre, 1921). Par Ed. le Danois. Pp. 16+6 plates. 4 francs. (Paris: Ed. Blondel la Rougery.)

Department of the Interior: United States Geological Survey. Professional Paper 131: Helium-bearing Natural Gas. By G. S. Rogers. Pp. 113. (Washington: Government Printing Office.)

Departement van Landbouw, Lijverheid en Handel. "'S Lands Plantentium." (Jardin Botanique de Buitenzorg.) Treubia: Recueil de Travaux Zoologiques, Hydrobiologiques et Oceanographiques. Vol. 1, Livraison 4. Pp. 139-300+plates 8-12. (Buitenzorg.) 4 francs.

The Botanical Society and Exchange Club of the British Isles. (Vol. 6, Part 1.) Report for 1920. By the Secretary, G. C. Druce. Pp. 207. (Oxford: The Secretary, Yardley Lodge.) 10s.

Fourteenth Annual Report (1920-21) presented by the Council to the Court of Governors at a Meeting held in Cardiff on October 28, 1921. Pp. 35. (Cardiff: The Museum.)

Canada. Department of Mines: Mines Branch. Bulletin No. 33: Gas Producer Trials with Alberta Coals. By J. Blizard and E. S. Malloch. (Supplementing Report No. 331.) Pp. 40. (Ottawa: Department of Public Printing and Stationery.)

Department of Scientific and Industrial Research. Building Research Board. Special Report No. 2: Experiments on Floors. An Extract from the Report of the Building Materials Research Committee. Pp. 21. 1s. 3d. net. Special Report No. 3: The Stability of Thin Walls. An Extract from the Report of the Building Materials Research Committee. Pp. 13. 6d. net. Fuel Research Board. Fuel for Motor Transport. Second Memorandum by the Fuel Research Board. Pp. iv+16. 6d. net. (London: H.M. Stationery Office.)

Mines Department: Miners' Lamps Committee. Memorandum No. 4: Record of Research on the Passage of Flame through Perforated Plates and through Tubes of Small Diameter. Pp. 19. 9d. net. Memorandum No. 5: Record of Research on the Passage of the Flame of an Explosion from within Miners' Lamps fitted with Chimneys. Pp. 13. 6d. net. (London: H.M. Stationery Office.)

Department of Commerce. Scientific Papers of the Bureau of Standards. No. 421: Wave Lengths longer than 5500A in the Arc Spectra of Yttrium, Lanthanum, and Cerium, and the Preparation of Pure and Rare Earth Elements. By C. C. Kiess and others. Pp. 315-352. (Washington: Government Printing Office.) 5 cents.

Union of South Africa. Department of Mines and Industries: Geological Survey. Sheet 52: Johannesburg. (Pretoria: Geological Survey.)

Proceedings of the Royal Irish Academy. Vol. 36, Section A, No. 1: On Polygons to Generate Diagrams of Max. Stress on Girders due to Locomotives and Dead Loads, together with an Extension of Rankine's Conjugate Load Areas to the Design of Masonry Arches. By T. Alexander and J. T. Jackson. Pp. ii+30. (Dublin: Hodges, Figgis & Co.; London: Williams and Norgate.) 1s.

Proceedings of the Geologists' Association. Vol. 33, Part 1. Pp. 80+4 plates. (London: E. Stanford, Ltd.) 5s. net.

Agricultural Research Institute, Pusa. Bulletin No. 117: Experiments with Castor Seed conducted at Sabour. By C. S. Taylor. Pp. ii+10. 3 annas. No. 119: The Agricultural Development of Baluchistan. By A. Howard and G. L. C. Howard. Pp. iv+27. 6 annas. No. 122: Pusa 12 and Pusa 4 in the Central Circle of the United Provinces. By B. C. Burt and others. Pp. iv+34. 11 annas. No. 124: Safflower Oil. By A. Howard and J. S. Remington. Pp. ii+14. 4 annas. (Calcutta: Government Printing Office.)

Diary of Societies.

THURSDAY, JANUARY 5.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 11.45 a.m.—R. L. Thompson and others: Discussion: Geography and History in Schools.

ASSOCIATION OF ASSISTANT MASTERS IN SECONDARY SCHOOLS (at London Day Training College), at 2.30.—Prof. T. P. Nunn: The Purposes of Education.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 2.30.—Sir Halford J. Mackinder: Problems of the Pacific.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Oscillations.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 4.—E. N. Fallaize: The Anthropological Institute and the Services it can render to Geographical Students.

CENTRAL ASSOCIATION FOR THE CARE OF THE MENTALLY DEFECTIVE (at University College), at 5.—Dr. G. A. Auden: The Possibility of Co-operation between the School Medical Officer and the Teacher in the Training of Subnormal and Mentally Defective Children.
LONDON HEAD TEACHERS' ASSOCIATION (at University College), at 5.30.—D. J. Collar and T. G. Tibbey: Intelligence Tests in Schools.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Cmdr. W. D. Beatty: Specialised Aircraft
GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 5.45.—Lord Robert Cecil: Presidential Address.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. P. Smith: Single and Three-phase Commutator Motors with Shunt and Series Characteristics.
PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—A. A. Campbell Swinton: The Johnsen-Rahbek Electrostatic Telephone and its Predecessors.
ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—B. Whitehouse: Salpingotomy *versus* Salpingectomy in the Treatment of Tubal Gestation.—J. B. Hunter: Short History and Post-mortem Notes of an Interesting Case of Diffuse Carcinoma following Cancer of Cervix.—A. W. Bourne: Hyperthyroidism in Functional Menorrhagia.

FRIDAY, JANUARY 6.

GEOGRAPHICAL ASSOCIATION (at King's College), at 10.20 a.m.—Dr. Fleure: The Co-operation of Historians and Geographers.
GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 3.—Miss L. Winchester: Some Climate Problems of Modern Palestine.—At 4.—Dr. Hogarth: The Hedjaz.
ROYAL GEOGRAPHICAL SOCIETY (Christmas Lectures to Young People) (at Æolian Hall), at 3.30.—Sir Francis Younghusband: Pictures from Mount Everest.
INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Society of Chemical Industry), at 6.—G. M. Gill: The Co-operation of the Engineer and Chemist in the Control of Plants and Processes.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—A. E. Bingham: Stone and Marble-working Machinery.

SATURDAY, JANUARY 7.

COLLEGE OF PRECEPTORS, at 11.30 a.m.—Prof. J. Adams: Psychoanalysis and its Value and Limitations from the Standpoint of the Practical Teacher.
ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Waves.
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—E. Kay Robinson: British Wild Life.

MONDAY, JANUARY 9.

ARISTOTELIAN SOCIETY (at 21 Gower Street, W.C.1), at 8.—Dr. F. C. S. Schiller, C. Joad, and Prof. R. F. A. Hoernlé: Discussion: Mr. Russell's "Analysis of Mind."
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.
SURVEYORS' INSTITUTION, at 8.—W. R. Davidge: Problems of Greater London.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Philip Brocklehurst: Across Wadai.

TUESDAY, JANUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Wireless Telephony.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—C. E. Tilley: Density, Refractivity, and Composition Relations of Some Natural Glasses.—A. Russell: Laurionite and Paralaurionite from Cornwall.—W. A. Richardson: A Simplification of the Rosewal Method of Micro-analysis.
INSTITUTION OF CIVIL ENGINEERS, at 6.—A. W. Rendell: Control of Trains in Relation to Increased Weight and Speed combined with Reduced Headway.—Sir Henry Fowler and H. N. Gresley: Trials in Connection with the Application of the Vacuum-brake for Long Freight Trains.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—Dr. B. T. J. Glover and others: Discussion: Should the Manufacturers Supply Figures indicating the Contrast Grading of Gas-light and Bromide Papers?—A. F. Kitching: Demonstration of Some Effects with Ultra-violet Light.—The General Electric Co., Ltd.: Developments Rendered Possible in Projection Work by the Introduction of the Osram Gas-filled Projector Type Lamp.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. C. Turney: Mosquito Investigation.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. A. O. Rankine: The Structure and Dimensions of Molecules.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. Whatmough: Rehtia, the Venetic Goddess of Healing.
ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. R. G. Rows: The Application of Modern Methods in the Treatment of Psychoses.

WEDNESDAY, JANUARY 11.

ROYAL SOCIETY OF ARTS (Mann Juvenile Lecture), at 3.—Dr. W. R. Ormandy: Clay: What it is, where it comes from, and what can be done with it.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. W. Monkhouse: The Economic Aspects of Various Methods of Power-transmission.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. F. W. Lanchester and R. H. Pearsall: An Investigation of Certain Aspects of the Two-stroke Engine for Automobile Vehicles.

THURSDAY, JANUARY 12.

ROYAL AERONAUTICAL SOCIETY (Juvenile Lecture) (at Royal Society of Arts), at 3.—Major D. C. H. Hume: Boats that Fly.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Exhibition of Cinematograph Films.—P. Torchio, with explanatory notes by Dr. C. C. Garrard: Investigations and Tests on High-tension Switchgear.—F. Gill: Telephone Inventors of To-day.—F. Gill: The Audion.—F. Gill: Electricity in the Home.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 2 Furnival Street, E.C.), at 7.30.—A. H. Keable: Super Centrifugal Force and its Application to the Clarification of Varnish and Dehydration of Oil.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. C. J. Peddle: The Manufacture of Optical Glass.—Dr. J. W. French: The Barr and Stroud 100 ft. Self-contained Base Rangefinder.—T. Smith: The Optical Three Apertures Problem.
INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute), at 8.—Col. N. Belaiew: The Inner Structure of the Crystalline Grain.
HARVEIAN SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.15.—Dr. G. de Bec Turtle: Some Points on Spasm in the Alimentary Tract (Presidential Address).

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. S. Paraskévopoulos: Jupiter in 1915 and 1916: Rotation Period in Different Latitudes, from Observations at the National Observatory, Athens.—Prof. G. Forbes: Solar Motion from 1922 Radial Velocities.—Major W. J. S. Lockyer: The Use of a Graduated Wedge in Stellar Classification and Parallax Work.

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